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PORCELAIN DENTAL RESTORATIONS

WITH A CHAPTER ON GOLD INLAYS

BY

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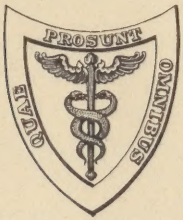
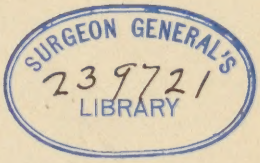
ILLUSTRATED WITH 294 ENGRAVINGS





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PREFACE.

MUCH has been written in dental literature on the various applications of porcelain in dental restorations, but little serious effort has been made to present the subject to the profession in text-book form. In an endeavor to meet the demand for such a work, I have yielded to the solicitation of many friends in the profession to present methods of practice which have been evolved after long years of experience in a manner which may be readily understood by the novice, as well as by the practitioner who is already more or less familiar with this branch of dental practice.

My many years of experience in the application of porcelain in dental restorations has not in the least decreased my enthusiasm for the work or my faith in its inherent value as the one filling material which most nearly meets the highest esthetic demands of a high class dental clientele. This belief and the hope that I may to some extent stimulate more interest in the use of porcelain for dental restorations have been the principal factors in inducing me to accede to the many requests for such a book at a time when the work involved infringes heavily upon the demands of a much crowded practice.

While gold inlays, strictly speaking, may be outside the scope of this work, I have, because of the similarity between the two methods of tooth restoration, the common principle of cavity preparation, cementation, etc., incorporated a chapter on this subject which I hope may be useful in pro-

moting the inlay method generally as a valuable means of tooth restoration.

I have freely quoted from and abstracted the writings of others, but with their full consent, and I take this opportunity of expressing my grateful appreciation to Dr. J. Melville Thompson for his generous contribution of the chapter on the Porcelain Jacket Crown; to Mr. Robert Brewster for that on Colors in Oil; to Dr. George H. Wilson for a large portion of the text used in the introductory chapter; to the late Dr. N. S. Jenkins and Dr. W. W. Bruck for the chapter on Low Fusing Porcelain Inlays and for much of the data concerning the history of the porcelain art and particularly that relating to low-fusing porcelain.

W. A. C.

PHILADELPHIA, 1920.

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CHAPTER I.

PORCELAIN.

PORCELAIN: ITS DEVELOPMENT AS A FILLING MATERIAL.

The use of porcelain for dental purposes originated in France early in the eighteenth century, and while porcelain teeth were in use in France a number of years previously it was not until 1817 that they were introduced in America by A. Plantou, a Frenchman, who brought to this country a number of porcelain teeth for dental use.

These teeth aroused much interest in America, where the great advantages of their use for artificial dentures were quickly realized.

Many dentists began experimental investigation into methods of making teeth for their own use, and it was but a few years before porcelain teeth were being manufactured and sold throughout the United States. Among the pioneers in this work was Dr. Elias Wildman, who in 1838 succeeded in producing mineral teeth that were transparent, granular in appearance, with flesh-like tint to the gums and unlimited shades and esthetic effect. When porcelain teeth were manufactured in sufficient quantities to supply the needs of the profession, many dentists turned their attention to the problem of perfecting porcelain to be used as the base for artificial dentures, and in 1845 Dr. John Allen, of Cincinnati, after several years of experimentation, gave to the profession a method of producing the continuous gum den-

ture, a denture which surpassed all previous substitutes for natural teeth, and to him undoubtedly belongs the priority of practical construction and perfecting of porcelain material for this purpose.

With the introduction of vulcanite as a base for artificial dentures this method almost immediately supplanted the continuous gum method, and was adopted by dentists almost universally.

Previous to 1885 the efforts of the investigative minds in this field were directed to the perfection of porcelain as a material for making artificial teeth for use in dentures, but there were those, however, who believed that porcelain could be utilized in other ways in dentistry, and through the efforts of men like C. H. Land, N. S. Jenkins and others porcelain came to be used for what may be termed minor restorations in the mouth. In the year 1887 was inaugurated a new era in porcelain work, when Dr. C. H. Land devised a method of burnishing a metal matrix in a tooth cavity in which porcelain could be fused. Much credit is due Dr. Land for his long and persistent efforts in this line of work.

The restoration of teeth by the porcelain inlay method has for many years been an important factor in the preservation of teeth, particularly those of poor structure, precluding the use of ordinary means of restoration through the use of mallet or hand-pressure gold fillings. The term inlay, accurately speaking, may be applied to any substance placed in the cavity, as in one piece, and held in position by an adhesive cement; but porcelain and gold are the generally accepted materials when "making an inlay" is spoken of.

The process of making a porcelain inlay is practically the same at present as when first introduced some twenty years ago, but the advent of the casting machine for gold has revolutionized that work and made it possible for every dentist to make inlays in a scientific and practical manner and enlarge his usefulness as an operator to the advantage of all concerned.

The desire for a more natural appearing material for tooth restoration existed many years before practical means were discovered, and much energy was expended toward

making porcelain in some form fulfil that requirement. Pieces of porcelain matching the natural tooth have in times past been ground to fit the cavities and then cemented to place; but this class of work is hardly feasible except in labial cavities or some regular surface of the front teeth. Ready-made porcelain inlays have been kept in stock for years at

FIG. 1.—Porcelain stoppers.

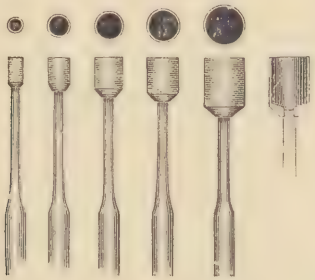


FIG. 2.—Dr. Weagant's diamond trephines.

the dental depots. They are in the form of rods in various shades and diameters, while others of different shapes and sizes are ground to fit the cavities and finally cemented in place, after which they are polished.

Some, however, instead of being ground to fit the cavity require the cavity to be shaped to fit the inlay (Fig. 1).

Dr. Geo. H. Weagant devised a set of instruments (Fig. 2)

suitable for this process, consisting of five trephines of consecutive sizes, made of copper charged with diamond dust. These instruments are intended to cut pieces of porcelain out of an artificial tooth that match the color of the nat-

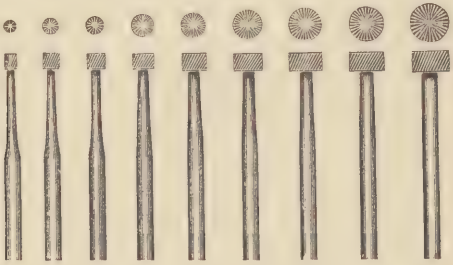
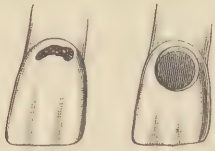


FIG. 3.—Dr. How's inlay burs.

ural tooth, and the cavity in the natural tooth is prepared with one of Dr. How's inlay burs (Fig. 3) corresponding in size to the trephine. This method has several serious objections, one of the principal being that in order to give the



a *b*

FIG. 4

cavity a circular shape much tooth structure is usually sacrificed. Take, for example, the decayed spot shown in Fig. 4 *a*. This would have to be enlarged as in Fig. 4 *b*, which is a serious objection.

HERBST'S GLASS FILLINGS.

As early as 1882 Dr. Herbst advocated glass fillings. These were made by taking impressions of the cavity in wax and making two molds in some such material as plaster

or asbestos. The ground glass was then flowed into the first mold, in which most of the shrinkage occurred. The partly formed filling was then removed and placed in the second mold, when more glass was added until the filling was complete. Even with this crude method the results were fairly satisfactory, although the margins were far from perfect and the glass was permeable to such an extent as to blacken; nevertheless, fillings were made that preserved the teeth for years.

DISCOVERY OF THE METAL MATRIX.

In 1887 Dr. C. H. Land made mechanically perfect edges possible by devising the metal matrix. Dr. Land used both gold and platinum, but found the latter preferable, as platinum could be adapted with a facility equal to gold, and permitted the use of high fusing tooth bodies much stronger and less likely to deteriorate than bodies capable of being fused on gold, which latter of necessity require so large a percentage of glass that they, like the fillings of Herbst, lacked permanence of gloss and color.

From Land's discovery dates all effective porcelain fillings. Before this, pieces of porcelain had been ground to fit labial cavities, with fair results, but the accurate adaptation of porcelain to proximal cavities was impossible until the metal matrix was evolved.

It is claimed that inlays are idealistic in their results, and this is undoubtedly true, providing certain considerations are adhered to. But it being impossible to make one material perfect under all circumstances, it is then necessary to resort to a combination that will lead to the best results. Porcelain inlays are ideal because when properly made they restore the tooth more closely to its original and natural appearance than gold or any other material. Its resisting qualities are much inferior to gold, therefore its value decreases if appearance and artistic quality are not first considerations. Gold in inlay form is then used, which justifies us in classifying the cemented inlay as an ideal means of restoration, unequalled and unchallenged.

In other words the use of porcelain for anterior teeth and gold for the wear and tear of posterior teeth have all the characteristics of ideal fillings, because they exclude germs of decay and preclude from growth those that enter. An inlay is a non-conductor of heat; it adheres to cavity walls, its manipulation is easy to the patient and conservative of tooth structure. It has:

1. Resistance to wear of mastication.
2. Resistance to the action of oral fluids.
3. Harmony of color when porcelain is used.
4. Exclusion of bacteria and preclusion from growth of those that may enter the margin.
5. Non-conductivity of heat and electricity.
6. Manipulation easy to patient.
7. Manipulation easy to operator.
8. Manipulation not destructive of healthy tooth structure.
9. Reinsertion with little preparation.
10. Duplication, which means that in many instances a duplicate is made and reserved by the operator for use in case of accident to the original.

INTRODUCTION OF LOW-FUSING PORCELAIN.

In the year 1898 Dr. N. S. Jenkins, of Dresden, aroused renewed interest in porcelain restorative work by presenting to the profession the so-called low-fusing porcelain materials, which because of the fact that the material could be fused at a temperature slightly lower than the melting-point of gold, made porcelain inlay restorations simpler and more readily available to the profession generally.

There are great possibilities in porcelain for dental restorations. It has come to stay and has filled a long-felt want in artistic dentistry. Since the methods of its production and use have been perfected it has become the *ne plus ultra* of all lovers of the harmonious in the "human face divine." The material and the methods of its employment are now so fully developed that every operator should be equipped for and should perfect himself in its use. In fact, so much progress has been made in this direction that there is no justification,

except in rare cases, for anyone to place a gold crown upon the anterior teeth.

There is no reason for expecting that a suitable low-fusing porcelain body will ever be attained, although it would be most desirable. The large majority of experienced workers of porcelain are satisfied that a medium high-fusing body is absolutely necessary. A porcelain body that will fuse at about 2300° F. temperature will answer every purpose.

COMPOSITION OF PORCELAIN.

The purest qualities of porcelain are made from three mineral substances: *quartz*, *kaolin* and *feldspar*. It so happens that these three minerals contain nothing but three oxids: Quartz is oxid of silicon or silicic acid; kaolin is the oxids of silicon and aluminum, the silicate of alumina; while feldspar is the double silicate of aluminum and potassium. It is to be noted that of the three oxids two are practically infusible, and insoluble in water, silica and alumina; one, potassa, is both very fusible and soluble. It follows, as a natural sequence, that two infusible, insoluble substances being combined with a very fusible and soluble material the latter will be disintegrated by either heat or water just in the ratio of the quantity of the fusible and soluble substance.

Quartz is ground to an impalpable powder, and as its fusing-point is much higher than the temperature used in baking porcelain it remains unchanged and serves as the framework of the porcelain.

Kaolin gives the properties of toughness and opaqueness; when subjected to high heat it adheres to the framework, quartz, and parting with its water of hydration shrinks very badly. If we mix these two materials together and bake them at the ordinary temperature of baking porcelain we will have an exceedingly porous mass resembling an unglazed brick.

Feldspar is a true chemical compound composed of silicic acid and the two bases, alumina and potassa. This is, strictly speaking, a natural high-fusing glass. The feldspar

fuses and forms a flux to solidly unite the particles of quartz and kaolin and fill all the spaces between the molecules of the mixture. The less flux used the higher the fusing-point and the less perfectly are the pores filled; consequently, the higher the fusing-point of the porcelain the more porous, and, conversely, the lower the fusing-point the less porous.

Another cause of porosity is overheating the porcelain so that its constituents are decomposed, producing certain gases which are caught by the viscid flux, thereby injuring the porcelain. The inherent cause of porosity in the low-fusing porcelain is the large amount of potash or its equivalent, and therefore that which is soluble in the fluids of the mouth. This explains why a medium-fusing porcelain is the best for crown and inlay work.

From the study of the various formulæ we find that all the higher-fusing bodies are composed of feldspar, silica and kaolin, while the lower-fusing bodies contain the same, with an additional amount of alkali. As they are fusible just in the ratio of the amount of alkali, we are justified in concluding that they are soluble just in the ratio of the degree of fusibility. Hence the low-fusing porcelain, containing a large amount of alkali, is not suitable for dental use. The kaolin, or clay, is formed in nature's laboratory by the action of frost and water in breaking up the feldspar rock and dissolving the potash. We know that a hard glazed surface will resist a reagent much longer than a rough or porous surface. Hence we infer that porcelain, though it may be highly charged with an alkali, will resist the fluids of the mouth much better if it has a highly glazed surface. This we find is true without an exception with the low-fusing bodies. As they come from the furnace they may resist the fluids of the mouth for a long time, but if they are ground and polished they will be more or less quickly disintegrated.

We may consider porcelain as an unfused glass, for it is true that all porcelain if subjected to a sufficiently high temperature will be converted into a transparent glass. Hence it is essential that porcelain be not overfused.

Without entering into a discussion of the characteristics of the various porcelain bodies or the relative merits of the

low-fusing and high-fusing systems I believe we are justified in assuming the following general statements to be true:

1. That the prime difference between glass and porcelain is the degree of fusion.

2. That fusibility is due to the amount of alkali contained.

3. That porosity is due to three causes: (*a*) The structure of high-fusing porcelain. (*b*) The overheating of any porcelain or glass. (*c*) The solution of the alkali in low-fusing porcelain or glass.

4. That porcelain bodies are stronger and more resisting than enamels.

5. That the highest-fusing dense material is the best for all dental operations.

6. That all porcelain work should be constructed of body and enamel. This is especially true of plates, bridges, crowns and large inlays.

CHAPTER II.

HIGH-FUSING PORCELAIN INLAYS.

PREPARATION OF CAVITIES.

The success of an inlay will depend largely upon four points of difference between its cavity preparation and that for those of foil, gutta-percha, amalgam or cements, viz.: upright walls, square enamel edges, no undercuts and depth. The walls being perpendicular, or nearly so, allow the easy withdrawal of the metal matrix either of platinum or gold, or in the case of the impression for casting with wax or any material for the purpose of making a model. The enamel edges are made square so that the inlay will have no overhanging frail edges of porcelain.

An undercut will prevent the easy removal of the matrix, frequently distorting it, and when using wax not even the slightest undercut is permissible. In connection with porcelain, depth of cavity has much to do with retention; in fact, it is more important than various keys and irregular forms advocated by many writers on this subject. Unfortunately we cannot always get sufficient depth, and, on the contrary, many cavities, when entirely cleared of decay, are too deep to obtain an unmutilated matrix, particularly with platinum; however, when this condition exists it is an easy matter to reduce it by partially filling the cavity with cement or gutta-percha.

The advantages of depth are retention, strength, through quantity of material, and purity of shade by having sufficient volume of porcelain, which assists materially in reducing the opacity caused by the cement.

This rule pertaining to deep cavities has not the same value when applied to the cast gold inlay, and it is well to note that the same rules which apply to porcelain inlays are

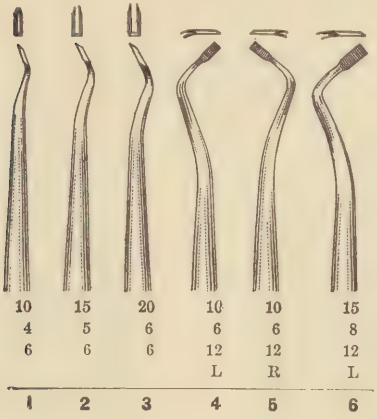


FIG. 5.—Simpson's automatic chisels (proximal).

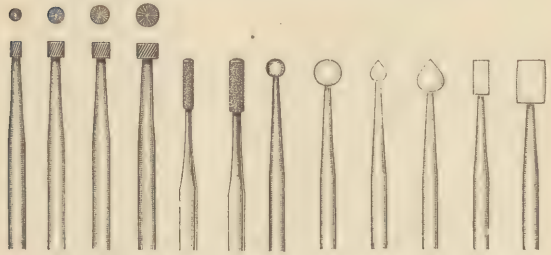


FIG. 6.—Burs and stones

applicable to matrix gold inlays, excepting that point pertaining to shading, because cavities prepared for matrices have always the burnishing feature prominent, which means curves and all surfaces accessible to the burnisher.

The formation of cavities is greatly assisted by special burs, stones and chisels of various sizes and curves, as illustrated in Figs. 5 and 6.

FIG. 7

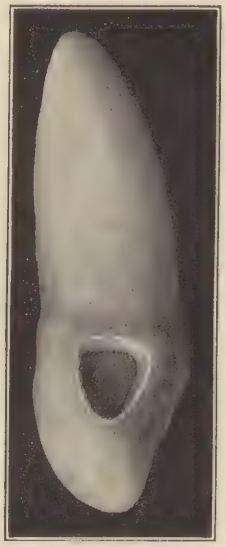


FIG. 8

The following representations of various cavities in natural teeth where porcelain is indicated and applicable are shown with the same cavity prepared and ready for the matrix. By this means the student will readily note what is requisite and necessary without detailed description and technical nomenclature.

Simple Cavities.—Figs. 7 to 14 show simple cavities, and in each case the border has been extended beyond the outline of decay, for the same consideration with respect to extension is applied in this class of work as if the cavity were to be filled with gold.

Figs. 15 and 16 are in the same class but are more difficult, for they have resulted from another cause, viz., abrasion or erosion, and it is noted particularly because this condition

FIG. 9

FIG. 10

FIG. 11

FIG. 12

is common and the cavity preparation much more difficult. The depth is insufficient and the margins are never defined,

FIG. 13

FIG. 14

FIG. 15

FIG. 16

which necessitates extensive cutting into hard and unusually sensitive dentin, and as this kind of cavity is almost as

FIG. 17

FIG. 18

FIG. 19

FIG. 20

FIG. 21

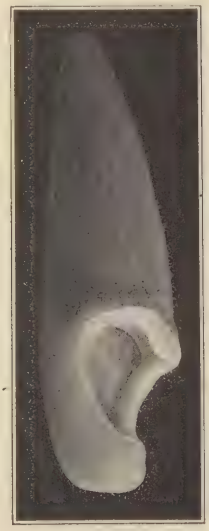


FIG. 22

FIG. 23

FIG. 24

common in lower teeth, the difficulty of preparation and general manipulation is increased. This applies to all labial cavities, and is noticed more in porcelain operations, because when the cavity is ready the matrix must be held in position firmly, a procedure interfered with by the lower lip and the saliva. The use of rubber dam is not desirable, because it reduces the working space, but it has other advantages occasionally.

Proximal Cavities.—Figs. 17 to 26 show cavities presenting greater difficulties both in preparation and general manipu-

FIG. 25

FIG. 26

lation. The preparation of cavities in such positions requires ample space between the adjoining teeth, otherwise a matrix cannot be withdrawn or the finished filling inserted. Sometimes it is impossible to get sufficient space for drawing the matrix without distortion; in such instances the cavity is prepared with this point as a first consideration. Fig. 26 shows a cavity of this kind. If there is not much difference in outline of the cavity labially or lingually, choose the labial side from which to remove the matrix; or, if cutting the labial margins does not interfere with the welfare of the

tooth, resort to this assistance in preference to difficulties of lingual matrix removals. In Figs. 18 and 20 the matrix under ordinary conditions will be withdrawn lingually. Figs. 19 and 21 show uncertain incisal edges, which are reduced in Figs. 22 and 24; therefore the difficulties of drawing a matrix in this case are very much reduced, for the cavity is so large that working space is greatly extended. Large proximal cavities of Fig. 21 type, where the incisal edge is of greater strength and is retained, are very difficult and frequent. The matrix formation requires skill and patience, but the reward is durability—for the inlay in this case is thoroughy protected and is rarely unseated.

FIG. 27

FIG. 28

Figs. 27 and 28 show a cavity on the gingival border extending under the gum margin and involving a considerable portion of the tooth mesially and distally. It is a typical representation of this form of cavity, and the position is one demanding a restoration with porcelain. The cavity walls are governed by its extent, for the matrix will warp if a strict rule of upright walls is carried out here. The cervical wall will not be at right angles to the pulpal wall or floor, or if so made they cannot be of that form at the extreme mesial and distal border; therefore in these cavities strict adher-

ence to a right angle upright wall is not possible for the best result. When the matrix is burnished it should be

FIG. 29

FIG. 30

FIG. 31

FIG. 32

packed with gum camphor in preference to other materials recommended. It is not always possible to make a very extensive inlay of this kind of one piece, therefore it should be divided at the median line of the tooth and two operations made.

Proximo-incisal Cavities.—Figs. 29 to 33 represent extensive proximal cavities or fractures extending to the incisal edge, and in a position where porcelain is of great importance. The apparent insufficient anchorage deters many operators from using porcelain, and the preparation of these cavities is the

Fig. 33

cause of more different opinions than any other. It is claimed that without a key or step on the lingual surface porcelain will not be retained by the ordinarily prepared cavity, and unnecessary cutting of good tooth structure is taught with most deplorable results. In many instances irregularity of cavity and its borders increase the matrix-formation difficulties, therefore a simple preparation is taken advantage of. With few exceptions the cavity can be prepared similarly to Fig. 29, defining the labial and lingual walls and anchorage increased by a groove with a round bur

at the gingival border resembling a deep undercut, as for a gold filling. Anchorage is also increased by grooving between the enamel plates at the incisal edge. The matrix must be burnished to these surfaces, otherwise the value of the preparation is lost. The labial outline (Fig. 32) can be varied in many ways, but angles are to be avoided whenever possible. Very often the corner is of the form of an irregular triangle tapering to a wedge point at the cutting edge. The porcelain at that point is very frail and will break, leaving an irreparable notch. To avoid this, cut an axial wall, as in Fig. 33, and thus make a body of porcelain, giving strength at a weak point. This same cavity is sometimes so extensive that anchorage is made by wire pins or staples. In instances in which the incisal section of the tooth has been lost by accident or decay this process of retention is preferable and highly recommended for permanency.

Fig. 34 shows a central tooth, a matrix and the porcelain section with wire anchorage. This case shows loss of one-fourth of the tooth and the cavity made by cutting the dentin to the required depth, an operation possible with few exceptions. The enamel edges are made true by a flat stone, after which the matrix is made of the walls and edges and shown without a floor. The wire is iridioplatinum, gauge 24, made in the form of a staple or loop and inserted while the matrix is in place; with these in position, porcelain in paste form is pressed over all and excess moisture is absorbed by holding a napkin or bibulous paper to its surface. The combination is carefully taken from the cavity and fused, thus forming a base with a wire loop or pins held securely without soldering. This foundation is now placed on the tooth and matrix edges thoroughly burnished, after which the operation is completed by repeated fusing. When the matrix is removed the contoured tip will resemble the third section of Fig. 34 and is ready for cementing. When the first porcelain is applied it will likely fill the loop, but this must not be corrected until after fusing, when the porcelain is easily broken away with blunt pliers. Frequently the staple or loop is inverted to suit conditions, but the form represented is the most durable in every particular. The difficulties of this

operation are increased by the irregular form of fracture, for usually they extend lingually and frequently quite to the gum margin; a restoration of this kind should not be

FIG. 34

attempted until the operator has had considerable practice, for the making of an incisal tip acceptably is one of the most difficult operations.

FIG. 35

FIG. 36

FIG. 37

FIG. 38

FIG. 39

FIG. 40

FIG. 41

FIG. 42

FIG. 43

FIG. 44

FIG. 45

Figs. 35 to 45 show the staples in various applications, including corner restorations.

Bicuspid and Molar Cavities.—Figs. 46 to 55 show cavities in bicuspids and molars for porcelain inlays. The forms are

very similar and directions for cavity technic are applicable in either instance. The value of porcelain in these positions is questioned because the force of contact is increased and the

FIG. 46

FIG. 47

FIG. 48

FIG 49

esthetic value is decreased. There are many exceptions, and the opportunities exist in mesial surfaces of superior bicuspids and molars. The occlusion is the first consideration, size and depth of cavity are next, although the latter is generally regulated by a step as shown in the sketches. This step is made of cement or gutta-percha and not of the same extent as if preparing for a gold inlay. The gingival borders are more curved and the step is rounded and allowance made for greater thickness of porcelain at the occlusal surface. The inlay will be more secure without a step or interior

FIG. 50

FIG. 51

preparation of any other material, but bicuspid and molar cavities are usually too deep for successful matrix formation. If this can be accomplished there still remains the difficulty of placing the inlay, because of greater bulk than it is possible to get space for; however, there can be no set rule; circumstances and good judgment must be factors at all times. In any case the cavity must not extend into the sulci between cusps unless the sulci are of sufficient size to assure strength of porcelain. Figs. 51, 53 and 55 show enamel surface edges without any extension to the sulci.

Figs. 56 to 64 represent what may be termed unusual cavities both in form and extent for porcelain inlays.

FIG. 52

FIG. 53

FIG. 54

FIG. 55

Fig. 56, incisal edge, requiring very accurate adaptation because of small opportunity of retention. If the mesial

and distal walls are not too thin on the incisal enamel a groove in the cavity will assist, but the general form of the tooth will govern this suggestion.

FIG. 56 FIG. 57 FIG. 58

Fig. 57, an unusually large form of labial cavity extending to the extreme mesial and distal borders and leaving only the lingual enamel plate.

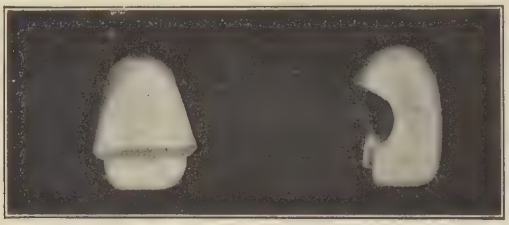


FIG. 59 FIG. 60

FIG. 61 FIG. 62

Fig. 58, a labial cavity toward the incisal edge, more frequently seen at the gingival border.

Fig. 59, represents a type of preparation for a porcelain tip, the original enamel being defective in form and color.

Fig. 60, a mesial cavity extending from the gingival border to the incisal edge of a central. The tooth decayed extensively labially and the lingual cutting edge shortened because of decay and weak enamel.

Fig. 61, linguo-mesial cavity extending to incisal edge. Lingual wall reduced because of weakness of enamel, but that loss is added strength to the porcelain inlay.

Fig. 62, an extensive labial cavity involving the whole mesial surface and extending lingually. In preparing this cavity the pulpal wall angles must not be so acute that the matrix cannot be withdrawn from the incisal section between the enamel plates, or reducing the axial wall at the incisal edge to a plain surface may be necessary to prevent distortion of the metal.

FIG. 63 FIG. 64

Fig. 63, incisal, labial and lingual preparation with angles to assist retention.

Fig. 64, lingual preparation for mesio-incisal restoration, more applicable to gold inlays. This form of retention for porcelain is not generally recommended because of increased difficulty in obtaining a matrix from the under surface and the doubtful assistance of a substance of such friable composition. It is a question.

PORCELAIN RESTORATIONS FOR CHILDREN'S TEETH.

One of the most difficult operations for any dentist is the restoration of a broken permanent incisor of a child

between the ages of seven and twelve years. The tooth is generally broken by an accident and frequently the pulp is not affected, but the tooth is extremely sensitive. If the pulp is exposed, devitalization is the only resort, and the restoration can be made with porcelain, using an iridio-platinum pin extending into the canal, or a wire loop of the same metal, No. 24, anchored in the remaining part of the crown.

This work is comparatively easy, because the main requisite for strength is anchorage, which is possible under these conditions. When the pulp is alive and apparently healthy it is generally desired that such a condition be preserved, which is not an easy matter under these circumstances. Something must be applied for protection and therefore cement is used because of its tenacity. No mechanical anchorage is possible. The child is young and the teeth are undeveloped, therefore they must be kept comfortable, if not presentable, for some years, for it is my experience that a case of this kind at the age mentioned is irresponsible and the dentist must bear the burden, which means continual replacement and general botheration. I recommend, therefore, that nothing permanent be attempted until the case has arrived at an age of maturity, when the patient is willing to use care with what has been done and has arrived at the age when personal appearance has some value.

A girl patient will be ready for a permanent operation about two years before a boy. Therefore, it is fairly safe to consider a finished operation at the age of thirteen to fifteen years. In the meantime, during the intervening years, fracture surfaces must be covered in some agreeable manner, and to that end I present the following plan of making a presentable restoration:

Fig. 65 represents the case of a boy, aged eight years, left central broken by a fall, pulp not exposed, but too sensitive to allow any instrumentation whatever. I kept the surface covered with cement for one year, which demonstrated the fact that the pulp was not materially affected by the fracture. The parents insisted that something more presentable be done, so an accurate impression of the broken

section was taken in plaster, and, after drying, a model was made of Mellotte's metal. Platinum foil No. 38 was swaged

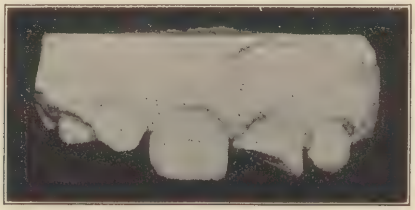


FIG. 65

to fit the broken surface, extending lingually to the gum line and labially 1 mm.

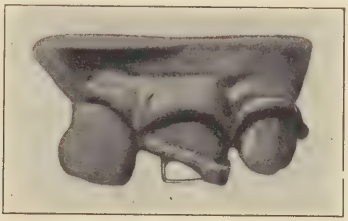


FIG. 66

This formed an accurate shell, which covered the tooth except on the labial and proximal surfaces. This thin

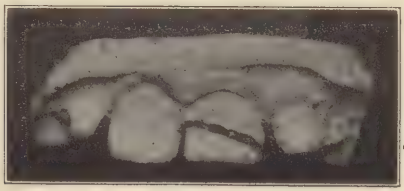


FIG. 67

platinum form was then reinforced by 25 per cent. platinum solder and a small staple attached to the broken surface

(Fig. 66) for the purpose of holding the porcelain. After three fusings the restoration was completed, as shown in Fig. 67. The small line of platinum on the labial surface did not detract from the finished operation to any objectionable extent, because the porcelain corner was so much greater in size; however, the improvement quite paid for the trouble.

Wire used for the staple was iridioplatinum No. 24. The surface of porcelain contact was etched to give every opportunity of attachment. This restoration was in use for five years and had the advantage of easy replacement of either the whole shell or repair of porcelain if necessary. If gold is preferred the metal can be cast direct to the foundation, which should be made of gold instead of platinum.

FORMATION OF THE MATRIX FOR PORCELAIN.

The difficulties pertaining to the making of a matrix are much reduced by having plenty of space between the teeth, and this must be obtained prior to the operation by means of tape, cotton or rubber wedges. Mechanical appliances may be used as an assistant when the inlay is made and the space for easy insertion is insufficient, but holding the teeth apart while making the matrix is usually an interference that can be avoided by giving this part of the work proper consideration. Room to work is a good rule to follow in any operation, but it is positively necessary with the inlay, because the mass is hard and unyielding, with breakable edges. It must be placed while the cement is soft and without delay, and the slightest interference may mean much loss of time and poor results.

A good inlay can be forced to place without damage, but an unpleasant experience or two with porcelain will demonstrate the desirability of having plenty of space.

The reproduction of the form of a cavity in foil for an inlay is called the matrix, in which the porcelain is molded by heating to a degree required to fuse the component parts of the material to a vitrified mass. The metal most generally used is pure platinum foil, $\frac{1}{1000}$ of an inch in thickness. Gold foil No. 40 is also largely used, but only in connection with

a low-fusing porcelain, which fuses at a temperature of 300° to 500° F. less than gold. Platinum has the advantage in the fact that it cannot be affected by any heat required to fuse the highest grade porcelain. It is not so ductile or so easily molded to form, but this disadvantage is counterbalanced by its stability, which allows greater freedom from care as to the changing of its form while filling with porcelain.

A gold matrix is invariably invested to prevent its changing form and protect it from overheat. This requires time and care, therefore platinum is more desirable from many points, and practice will assist greatly toward easy manipulation. There has been much discussion in the past upon the proper thickness of the platinum, but it is now generally conceded

Fig. 68

that $\frac{1}{1000}$ of an inch will suit all cases better than any degree thinner or thicker. A thinner material has not the stretching quality, and anything heavier will cause a thicker cement line.

A simple cavity on the labial surface of a central will serve to illustrate the mode of procedure, which is the cutting of a square section of the foil sufficiently large to extend over the adjoining teeth, holding the corners in the manner of Fig. 68, and while held securely by the fingers, press the foil over the cavity with some material such as spunk, cotton, small chamois disks or a soft rubber point like a pencil end, and in this manner the cavity will be outlined on the foil and that portion covering the cavity concaved, so there can be no

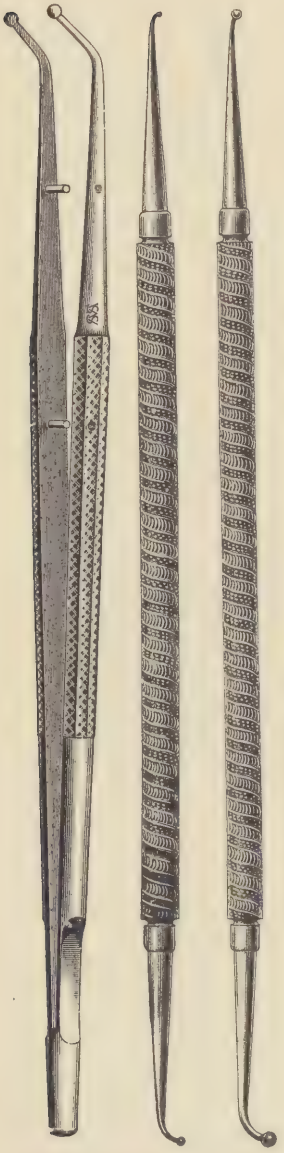


FIG. 69 FIG. 70 FIG. 71

mistake as to what portion is to be burnished. Then use ball-pointed burnishers of various sizes, such as amalgam instruments shown in Figs. 69 to 71, and gently rotate, gradually pushing the burnished surface to the cavity walls and floor, using care not to break the margins. The metal will probably split or break as it is forced to place, but unless extremely ruptured it will not interfere with final results. When the interior portion is fairly fitted, packed with spunk, cotton or gum camphor, and held securely with a blunt instrument, a flat, blunt instrument should be used to get perfect margins. Then the packing is removed (except when using camphor, which is burnt out), the matrix released with very fine pointed pliers and results noted. Three desirable sets of burnishing instruments are illustrated in Figs. 72, 73 and 74.

If satisfactory the next step is filling the mold with porcelain.

Platinum foil should be thoroughly annealed in the furnace muffle; the heat required to improve its softness is at least 2200° F. The foil purchased at the present time is usually ready for making the matrix, having already been thoroughly softened at a very high temperature. A matrix of complex character will require more than usual burnishing, which will have a tendency to make the

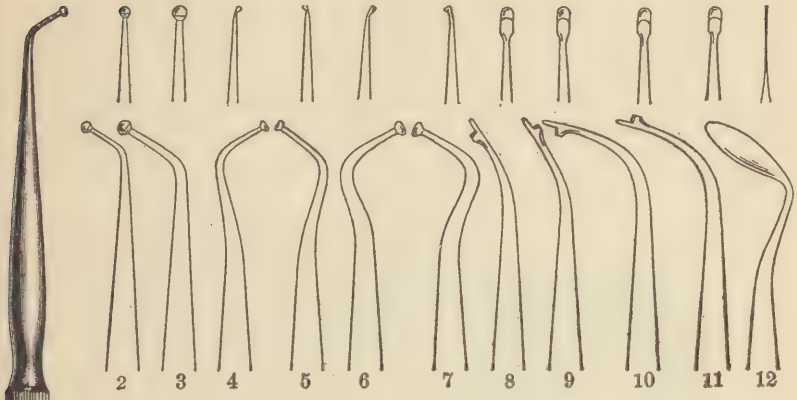


FIG. 72.—Reeves's set of inlay burnishers.

metal harsh. It can then be re-annealed to advantage, provided the temperature is not less than the degree already mentioned.

An excess of material is recommended in labial cavities for the purpose of holding securely, but in other places the reverse is desired, notably on proximal surfaces, where the excess will interfere with removal after taking the form of the tooth. Burnishing the matrix in proximal cavities, corners and tips is greatly assisted by strips of either cotton, rubber dam or goldbeaters' skin held securely over the metal, insuring its proper position and preventing tearing on the sharp cavity edges (Fig. 75). Avoid lapping or folding of matrix on cavity edges.

After the matrix is made the next procedure is filling it with porcelain. This is done by holding the mold in straight, fine-pointed pliers, applying the porcelain with a fine sable pencil brush or with a spatula made for the purpose (Figs. 76 and 77). The porcelain powder is mixed with pure water, distilled preferably, into a stiff paste, and after applying it is shaken to position either by tapping or drawing the serrated instrument handle across the pliers. This jarring brings the moisture to the surface, and after tracing the cavity outline and removing the excess with a brush it is laid, face down, on a clean towel, bibulous or blotting paper,

which absorbs the excess moisture. The inlay is then dried out in front of the furnace muffle, gradually pushed into the furnace and fused. Too rapid drying will cause the porcelain to jump from the mold. A high fusing porcelain mixed into a stiff paste will shrink about one-fifth its bulk,

FIG. 73.—Weber's glass burnishers.

therefore a second or third fusing is required before the inlay can be called finished. If the porcelain is thin its proportion of shrinkage will be greater, and it will not bridge or carry its weight across any tear or aperture that may exist in the bottom of the matrix; and in deep cavities this condition is nearly always present, therefore it is necessary to always

turn the matrix wrong side up and carefully note its condition. Clean off any excess with the brush and thus avoid a misfit, for it is impossible to remove fused porcelain without distorting the matrix or totally destroying the work up to this point.

FUSING THE INLAY.

The first fusing is usually called "first bake" or "biscuit," which is a state wherein the component parts of porcelain are brought together by the heat and made into a hard, homogeneous mass without gloss.

It is at this stage that shrinkage is most apparent, and it is a condition that exists in every porcelain operation of whatever dimensions. Shrinkage is governed by quantity and quality of material, and is a prominent factor toward success or failure. In small inlays shrinkage is of less import, but in proportion to size it must be dealt with. This shrinkage may be sufficient to distort the matrix or cause porcelain to attach to the matrix walls. As it is never consistent it is very important to control it, but this is only possible to a small extent. Shrinkage toward the matrix wall is most desired and can be assisted by a slight cut or groove across its greatest extent, thereby giving the porcelain an impetus in that direction. In large spaces much assistance in controlling shrinkage is secured from using small particles of baked porcelain mixed with the unfused paste.

After the first fusing of the inlay the excess platinum or matrix material should be trimmed, leaving a working margin to allow a refitting in the cavity. In small, simple cases this may not be necessary, but in the majority of cavities it will assist greatly. If the matrix has become slightly altered by shrinkage or careless handling the change is noted at once and corrected. In contour work it will assist the eye to determine where to add or reduce; in fact, there can be only very small argument against a trial of the embryo inlay in its place and reburnishing the cavity edges.

Selecting the shade is the first requirement, as the foundation should approximate the final shade; but after the inlay is reburnished this question must be settled in the

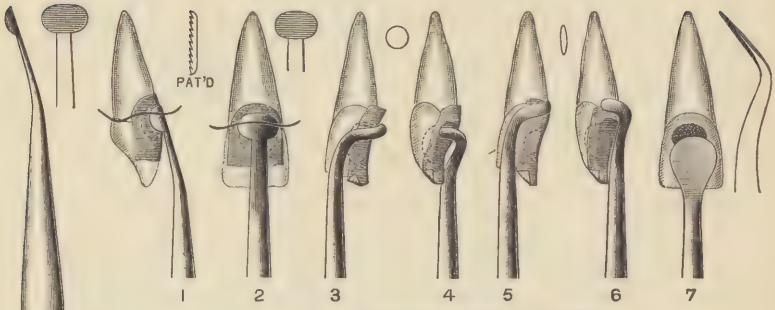


FIG. 74.—Sausser's matrix burnishers.

operator's mind and the final fusing proceeded with. First, clean off the inlay with a brush dipped in alcohol or warm water, thus removing saliva, blood or any undesirable particles, then carefully fill any crevice caused by shrinkage or breakage, finally filling the matrix or building the contour or section as desired, always considering shrinkage. A second bake may be sufficient, but usually a third is required or even a fourth. Frequent firing is not harmful, providing the porcelain has not been carried to a finishing heat previously. Shrinkage must be overcome, therefore withdraw the work from the furnace before it is fused and note its condition.

After the inlay is properly fired the matrix is removed by turning the metal back from the edge with pointed pliers, releasing the inlay. Frequently small particles of metal adhere to the porcelain. If a pointed instrument fails to remove these use a discarded bur, but in larger inlays small quantities of adhering metal will make no difference in any way. The inlay is now tried in place, having the cavity wet, which helps the porcelain to blend with the natural tooth, and at this stage the patient should be shown the results, for at a later period the cement and drying of the tooth make a change not always satisfactory, but fortunately this is largely corrected by time.

The inlay is grooved or undercut by wheel disks such as hard-rubber, corundum or copper coated with diamond

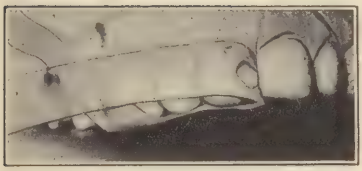


FIG. 75

FIG. 76

dust. An additional retention is secured by using hydrofluoric acid. This acid has a great affinity for all vitrified surfaces, therefore great care is necessary that the outer and finished surface is thoroughly protected, and the most simple method is to soften the surface of a small piece of paraffin or beeswax and embed the inlay face downward. Then cover the exposed surface with a few drops of the hydrofluoric acid and after about five minutes wash with a spray of water.

The use of acid for this purpose is very common and the tendency to carelessness is sometimes checked by a bad burn, which is always painful and very slow to heal. After the inlay has been subjected to acid it should be soaked in alcohol. This will soften the white scale, which is removed by scraping the surface with a sharp instrument and thereby give the cement a better attachment to the roughened surface. This is a point not generally considered, but it is reasonable and practicable, and many small inlays have been lost through non-observance of this fact.

As the inlay is now ready for inserting, the tooth is dried and protected from moisture either by napkins or rubber dam. The latter is preferable, but not necessary, provided the operator can use a napkin properly. Successful inlays depend upon perfect adaptation and cementation, but frequently the operation is spoiled through carelessness or a desire to hurry the case to a

FIG. 77

finish; therefore too much stress cannot be placed on this important part of the work. The cement, the shade of which should approximate that of the tooth and inlay, must be mixed thoroughly, be of creamy consistency and of medium to slow-setting quality. Apply it to the cavity with a small spatula tip, then gently press the inlay into position, wipe off the excess with spunk or tape and note the line of demarcation. If this is satisfactory hold the inlay in position until the cement has commenced to harden, then protect from moisture by covering with melted paraffin, wax, sandarac varnish or chloro-percha. If the inlay is extensive it can be ligated with floss silk or held by a wedge, always avoiding the use of excessive force, or the delicate porcelain edges will shatter.

A later sitting is required for a final finishing, for the best of inlays will need smoothing of edges, which is done with small stones or sandpaper disks and strips.

MAKING INLAYS BY THE INDIRECT METHOD.

While the majority of porcelain workers are satisfied that the best results are to be obtained by working directly on the tooth from start to finish, it is claimed by others that results equally as good may be had by swaging, or by what was originally known as the water-bag process, introduced a few years ago by a London manufacturing firm.

The system has some ardent supporters, who claim that by it the presence of the patient is needed only for the impression and the finish of the inlay, the rest of the operation being done in the patient's absence and by a laboratory assistant if so desired. The claim is plausible, and the fact that many dentists use this process makes it worthy of consideration.

Dr. F. T. Van Woert is an ardent supporter of this form of operating and in an article on this subject says: "The essentials necessary for securing an accurate impression of any cavity are (1) suitable trays; (2) proper impression material; and (3) a knowledge of its manipulation.

"The material for trays which has given me the most

satisfaction is sheet platinoid of 32, 34 and 36 gauge, because it has a rigidity, together with more pliability than any other metal that I have been able to find. Another very good quality, while not essential, is that it has a finely finished surface, which at least has the appearance of being clean, and is pleasing to the patient. The second requisite is the impression material, and while it is a matter of opinion, personally, I prefer that made by the Detroit Dental Mfg. Co., because it softens at a lower temperature, sets quicker, and when cold is as hard, if not harder, and gives a very much sharper definition of detail than others I have tried. After forming the tray a suitable quantity of compound is heated, the tray held over the flame until it is hot enough for the material to adhere to it, and the compound then pressed into a cone-shaped mass with the fingers and then chilled. The surface of the cone should be held in a small flame, so that it is quickly heated to the point of running, and then forced into position, and either compressed air or cold water used for setting it.

"I find it a great advantage in large cavities in molars and bicuspids to force between the tray and adjoining tooth the blade of a thin cement spatula to bring up a sharp line at the cervix. This is easily removed after the chilling and facilitates the removal of the impression as well. This is frequently advantageous in approximal cavities of the anterior teeth also.

"**Method of Making Amalgam Models.**—If we have succeeded in securing an accurate impression it is only the beginning of a successful ultimate result, and the next procedure, that of making the model, requires as careful consideration and manipulation as any part of the technic. Various materials have been recommended for this purpose, all of which I have given a most careful and impartial trial, and I am forced to the conclusion that there is but one reliable material, and that is a good amalgam. When I say 'a good amalgam,' I mean one having good edge strength, as little shrinkage as possible and the property of setting quickly, although this is not essential. I use the standard alloy made after one of Dr. Black's formulæ.

"First, the impression must be embedded in plaster to a sufficient depth, and with enough body surrounding it to permit of pressing the amalgam well down into the impression. The amalgam is then mixed with enough mercury to make it very plastic, and this is burnished into place with suitable instruments until the impression is filled. Then the excess of mercury can be eliminated by folding a piece of rubber dam several times and placing it on the amalgam and pressing upon it with the thumb.

"The mixing of the amalgam is one of the most important points in the procedure. In my early efforts I tried to fill these impressions as I would a cavity in a tooth, and the force required in burnishing it to place invariably marred, the impression which resulted in an imperfect model of the cavity.

"**Advantages of Impression Method.**—If we succeed in getting an accurate model, a filling made to fit it must fit the cavity which it represents. This being the case, let us consider the advantages to be derived from the impression method: First, we are none of us so perfect in any branch of our art that we are not liable to make mistakes. Second, it is beyond question that we all have many accidents that are just as deplorable as the mistakes we might make, and when such happen in the direct method of making inlays we are obliged to acquaint our patients with the fact that we have erred, or met with a misfortune in the form of an accident, either of which is humiliating to the operator and frequently exasperating to the patient, and, occasionally, to such an extent that the patient loses confidence and seeks service elsewhere.

"We will take, for example, porcelain restorations. In the direct method, where the matrix is burnished to the cavity, which, by the way, is a much more tedious operation than that of taking an impression, we have confronting us the possibility of some distortion in its removal, or, perhaps, in the handling after it has been successfully removed, as well as the possibility of warping in the fusing of the porcelain itself. There is still further the difficulty which arises in many cases of securing a suitable color, or just the proper

form of contour, all of which is a large combination of defects which remains to be explained to the patient.

"The impression method eliminates all of these difficulties. In the first place the matrix is secured by swaging the gold into the die with the Brewster press (Fig. 78) and the swaged matrix is less likely to change its shape when removed than the burnished one. The shape of the swaged matrix can be retained by filling it with a hard wax; it is then removed and invested, and later the wax washed out. Should the filling prove a failure, another, or several others, if necessary, can be made without the patient's knowledge; and where the question of color or contour is liable to cause trouble, several fillings, varying from a light to a dark shade, can be made; or if it be a troublesome contour, several of different shapes, so that when the patient presents, the suitable filling can be selected without subjecting him to another or several operations, and without the unnecessary loss of time to the operator.

"**Cast-gold Fillings.**—The same procedure is applicable with cast-gold inlays, with the exception that the wax filling is fitted to the tooth, as described by Dr. Taggart, omitting the final carving of detail in bite and contour which should be done on the die. If the die is correct the wax filling will go to place without difficulty; but one is surprised to note the little defects in the filling, such as here and there a small point where the wax has not conformed to the sharp edge of the cavity margin. This is due to the lack of resistance at such places, the wax being of one temperature throughout its entire body, it is forced by the occlusion from inward out and on a line with the cavity margin. It may be said that this defect can be remedied by running a hot spatula around the line, but I have found this extremely difficult, particularly at the cervix. It is also claimed that such defects may be corrected by burnishing the gold casting after it has been cemented to place. This has proved just as difficult and unreliable in my hands; and it is a potent point that these difficulties do not exist when cast fillings are made from the impression and amalgam model properly constructed."

SWAGING THE PLATINUM MATRIX.

The cavity is prepared as described for the usual method, edges square, margins strong and without undercut. Talcum powder is rubbed into the cavity and on the adjacent surfaces.

Then an impression is taken in cement. This is invested in plaster of Paris, and the surplus cement, which extended around the tooth on both sides of the cavity, is trimmed away to about one-sixteenth of an inch from the margins. Additional cement is then mixed to a very stiff consistence, the fingers being dipped in talcum powder and the cement well kneaded. The first impression is surfaced with talcum, and this second mix pressed into the first one and allowed to stand until quite hard. Then separate and invest this second impression or model in one of the steel cups, in plaster, or, if preferred, in one of the very shallow cups, in cement or sealing wax. Invest so that the center is slightly higher than the edges of the cup. When the plaster is hard, place a square piece of platinum (one one-thousandth of an inch thick) on the cement model. With pledgets of cotton-wool press the platinum down into the cavity; put into the swager, with a water-bag over the wool, and swage. Remove from the swager and burnish out wrinkles or folds; then anneal well in the furnace, replace on the model and re-swage with water-bag, but without the wool. Reverse the press handles, remove the cup from the cylinder and examine the matrix. If any wrinkles or folds still remain on the margins they must be burnished out, and if the matrix does not appear to be perfectly adapted to all parts of the cavity it should be again annealed and then subjected to harder pressure in the swager. Any crack in the matrix at the bottom or near the bottom of the cavity will not affect the fit of an inlay.

In building in the porcelain where the cavity is a large one, first grind an "inlay rod" to fit tightly across the matrix at its widest part; surround this, except upon its upper surface, with foundation body; and when it is quite dry, bake. Keep the foundation body sufficiently away from margins to allow for the thickness of enamel body necessary to pro-

duce the desired color. When baked return to the model, and if baking the foundation body has caused any change in

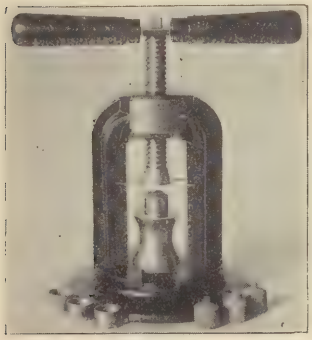


FIG. 78

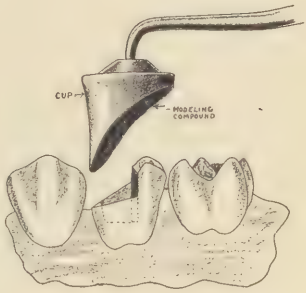


FIG. 79

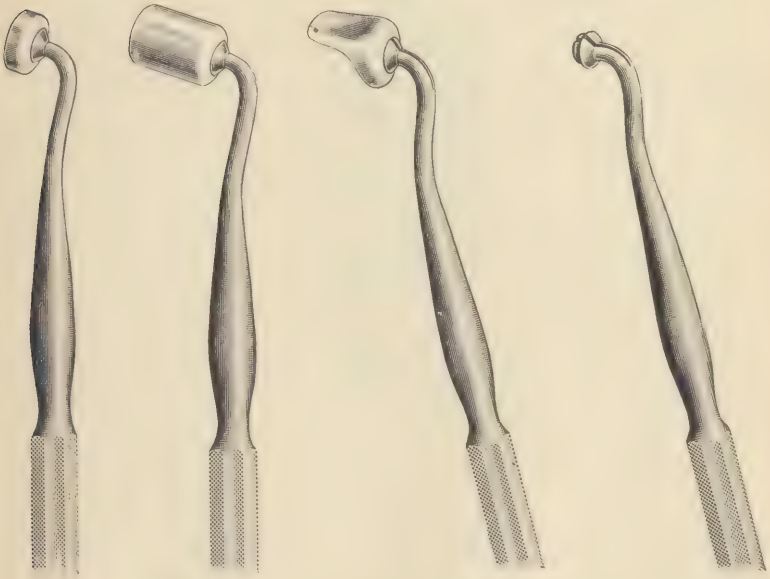


FIG. 80 FIG. 81

the fit of the matrix, the next swaging will correct it. After this last swaging proceed to fill in the enamel body. Lay the

dark shades in first and bake, then add the lighter colors necessary to finish. The foundation body first baked in the matrix will prevent any change of form during the baking of the enamel body.

The press should be screwed to the bench. The solid rubber is for swaging heavy metal cusps and also for inlays. Should a water-bag break, carefully dry out the cylinder and plunger. Do not allow any rust to accumulate in the cylinder. The inlay rods above mentioned are made of high-fusing material and are of assistance in large contour work by other methods.

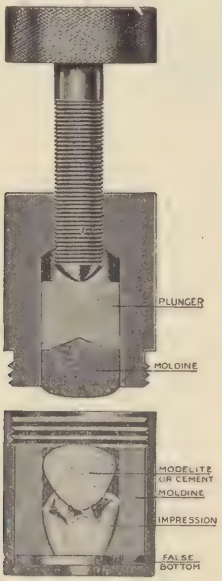


FIG. 82

The most recent appliance for this process is the Roach model press with trays, which are cut to form of cavity and are recommended for bicuspids and molars (Figs. 79, 80, 81 and 82).

FUSING PORCELAIN.

For many years there was much controversy regarding the qualities of various products, particularly between the

advocates of a high heat porcelain and those of low-fusing qualities. While this question is still debatable it is an indisputable fact that in America porcelains of the higher grade have the preference. This may be from the fact that the manufacturers of artificial teeth in this country have always used a high-fusing material, and as the product has stood the test of time, it is only natural to apply this argument to the inlay question.

English tooth body fuses about 400° F. lower than the highest fusing American body, which places the English on our list as a medium fusing material, and its excellent quality is indisputable; in fact, the majority of our inlay bodies fuse at a medium heat, ranging from 2150° F. to 2300° F., therefore the difference between this fusing degree and that of low body of 1600° F. or thereabouts is the point of argument.

When porcelain inlays were introduced the standard material was the continuous gum bodies then well known to porcelain workers and put on the market for their use. It was the only material to be had, and while it possessed the required quality it had no variety of shade. After some years this was remedied, and the advent of the pyrometer enabled us to learn the approximate fusing temperatures of the old continuous gum bodies which were found to be about 2300° F. These bodies have not been much improved upon either in quality or finish. The first low fusing material was introduced in 1892 by Dr. Downie, but was not satisfactory for inlay work because of its poor shades, although it was quite extensively used for crowns. A few years later Ash & Sons made up a small assortment much improved in shades. Dr. Jenkins introduced his low-fusing enamel in 1898. After this date manufacturers of porcelain produced an assortment suitable to all circumstances.

The wearing qualities of various porcelains are practically equal in certain positions, notably in cavities not extending to incisal edges or masticating surfaces and in shallow labial cavities. Low-fusing porcelain has an advantage from the fact that its opacity prevents the cement from changing the shade, which is frequently the case with a high-fusing and more translucent body. Workers of higher fusing porcelain

will be more or less conversant with all porcelains and their variations, because this field is greater and has practically no limitation; but a low-fusing porcelain worker is usually at sea if not using that material, while anyone accustomed to the higher heats can fuse the lower, provided care is used not to overheat. Too much heat is fatal to low fusing body, as it means not only loss of shade, but also loss of strength. The same rule applies to all porcelains, but not to the same extent if the porcelain is high fusing, for its working latitude is much greater. Low-fusing material is usually molded in a gold matrix which is invested. Platinum must be used as the matrix for higher heat porcelains, and no investment of it is necessary.

As pyrometers are commonly used a list of the most popular bodies and approximate fusing-points will assist the student, bearing in mind that these figures are based on two-minute tests, with conditions favorable for accuracy.

Low Fusing.	Medium Fusing.
Ash & Sons, 1550° F.	S. S. White's Medium, 2100° F.
Jenkins, 1550° F.	Ash & Sons' "High," 1900° F.

High fusing.

S. S. White's Inlay, 2300° F.
Close's Continuous Gum, 2300° F.
Whiteley's Inlay, 2200° F.
Whiteley's Inlay special, 2400° F.
Consolidated Inlay, 2600° F.
Johnson & Lund's, 2500° F.

It is generally conceded that fusing porcelain is one of the greatest difficulties that must be overcome before the novice can feel that he has made any advancement toward the successful making of an inlay or anything in which porcelain is the component part. It is an indisputable fact that this part of the work is a veritable stumbling-block, and the cause of much discouragement which is only overcome by persistent practice, for without this necessary knowledge successful results are not possible.

Porcelain may have a fusing-point as low as 1600° F. and varying to 2600° F., or even higher, therefore the operator must become familiar with these varied heats and their productions. This will mean continuous application and

training the eye to the various stages and changes of the material. Using a timepiece with a pyrometer will be of great assistance, but the personal equation is always the dominant factor, and herein lies the difficulty of giving directions that will be accurate under all conditions. Before the advent of the pyrometer the eye was the only test of heat, therefore to the beginner this device has considerable value, together with the fact that the fusing-points of the numerous porcelains are known. Thus a certain time by the watch with the fusing-point of the porcelain already known and the pyrometer showing the temperature the fusing of porcelain seems comparatively easy. Various sizes of porcelain require different heats, therefore it is absolutely necessary to know porcelain in all its changes, without any assistance whatever, otherwise the work will be either over- or under-fused, and only by chance will it be correct if the machines are depended upon entirely. There can be no difference of opinion on this fact, therefore the best equipment is the personal knowledge which makes one independent of any appliance or set of rules and regulations. It is generally contended that exposing the eye to such severe changes of light is injurious, and this may be true beyond a certain point, viz., 2300° F., a temperature sufficient for the majority of our porcelains. There is a product by a well-known firm which requires a heat of 2600° F., and there is no doubt that the eyes should be protected from the glare of this heat, which is unnecessarily high, especially for inlay work.

As electric furnaces are most commonly used for fusing porcelain it is not very difficult for the student to become familiar with the various changes of heat as regulated by the rheostat and thereby know what step will fuse a certain known product. For instance the first step on the majority of furnaces will fuse a low-fusing body of 1600° F. in probably one minute or even less, but the same heat will fuse a much higher porcelain if given longer time. Then, again, voltage must be considered, for in many cases it is only approximate, sometimes varying three or four points less or that much more and still coming under the class of 110 volts direct. This fact is particularly noticeable in local establishments,

such as office buildings. The alternating current is usually more even, that of 220, however, being very strong and harder on the furnace muffles.

The best fusing is obtained by inserting the porcelain at the lowest temperature and gradually and slowly raising the heat until the fusing-point is obtained, thus passing the material through its various stages of condensation. These stages are called "biscuiting," and a porcelain partially fused may be called a medium or hard biscuit. In the latter condition the porcelain has a half-glaze and has shrunk to a solid mass and is ready for the additional material required to give form. Then the porcelain can be fired until it has the finished gloss, which is determined by the eye of the manipulator. The best results are always obtained by underfusing the first bake, because several high heats will overfuse the groundwork, which reduces its strength and solidity. Using a porcelain of slightly lower fusing-point the finishing will obviate this tendency, which is detrimental to the whole work.

As an instance of this, note a manufactured tooth which is finished in one baking and the same directions are applicable to carved teeth for special cases. A student will readily learn the proper glaze required if he will take any plain or plate tooth and apply porcelain to its surface and watch the various changes until his material has reached the same condition. This simple experiment will also help him to recognize the heat required for these changes and ultimately enable him to acquire self-confidence in the management of the fusing process.

Porcelain bodies made for inlay purposes are to be had in great variety, both in fusing-point and texture; in fact, there is such a number for choice that the inexperienced must necessarily be bewildered.

However, this difficulty will settle itself like many others that may at one time have been just as perplexing.

FURNACES.

The advancement in the matter of furnaces has been so rapid that less than thirty years ago the user of porcelain

depended on such an apparently crude appliance as is shown in Fig. 85 (old coke furnace), and yet the beautiful porcelain dentures and carved work of the older dentists has not been surpassed.

It was early recognized that a small, quick-heating appliance was a necessity, and this difficulty was solved by Dr.

Fig. 83.—Custer No. 1, for crown, bridge and inlay work.

C. H. Land by inventing the first gas furnace in 1886. This machine, while a great improvement, was slow and tiresome, as the constant use of bellows was necessary for half an hour before the furnace was hot enough for use. A smaller and quicker heating gas furnace succeeded this, more applicable for inlays and crowns, and was successfully used until super-

seded by electrical outfits, which have the advantage of cleanliness, purity and noiselessness.

A gas furnace is noisy and gives much trouble in carbonizing the porcelain, or, as it is usually termed, "gassing." Fortunately, that is a discouragement of the past, for

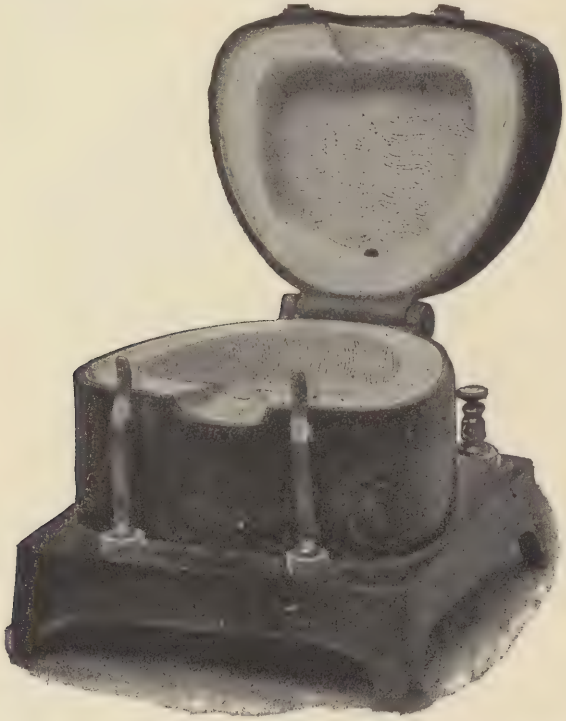


FIG. 84.—Custer No. 2, for crown, bridge, inlay and continuous gum work.

electricity has reduced fusing cares to the minimum. Other furnaces of that time were the Parker-Stoddard, Downie and Fletcher.

Dr. L. E. Custer invented the first electric furnace in 1894, and while it was a distinct improvement, there was much

trouble in muffle wires burning out, which caused much delay and retarded the general use of this class of furnace. The Custer electric furnaces (Figs. 83 and 84) as now perfected are practically useful and are strong favorites. Five years later the Hammond was patented and immediately became popular from the fact that a "damaged" muffle could be replaced immediately. (Fig. 86).

This furnace has remained a favorite until the present time, but is being gradually replaced by the S. S. White Co.'s

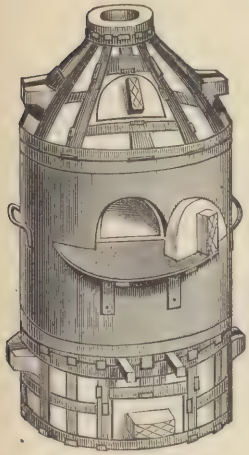


Fig. 85.—Old style coke furnace.

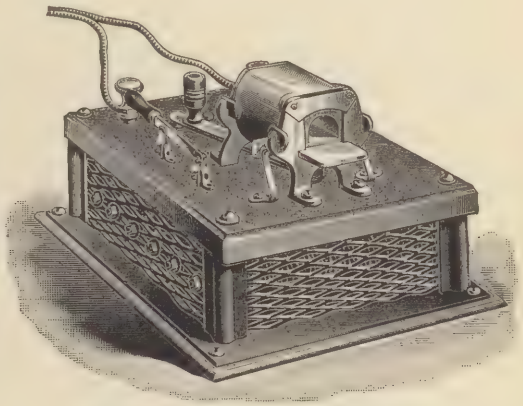


Fig. 86.—The Hammond furnace No. 1.

new furnace (Fig. 87), which is similar, but improved in certain details, and it is also arranged with pyrometer attachment.

In 1902 the Pelton appeared. Besides these furnaces there are several others distinct in form, and all, with few exceptions, have a pyrometer attachment. They are the Fletcher, Peck, Gerhardt and Roach and others, including the Price, which has been withdrawn, although Dr. Price was the first to apply the pyrometer.

In addition, furnaces are also made for gasoline use. The principal types are the Turner and Brophy. They are of

great value to the out-of-town dentist, because they not only fuse porcelain, but have equal facility in blow-pipe work and

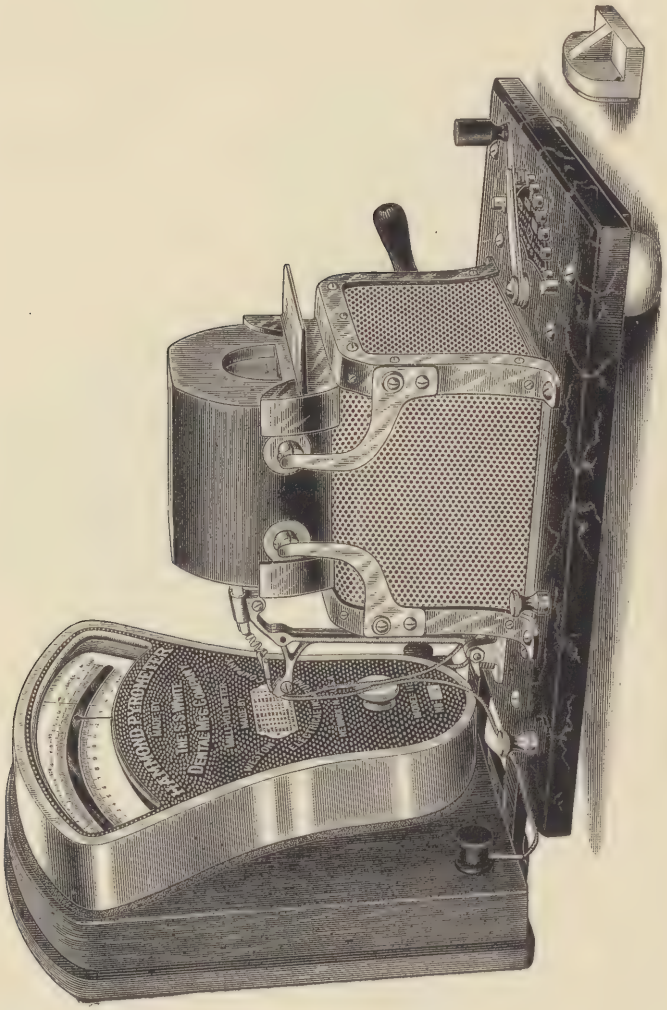


FIG. 87.—S. S. White furnace with pyrometer attachment.

metal heating, thus enabling those not possessing gas or electricity to be practically on the same footing with the city practitioner.

PRODUCING PROPER COLORS IN PORCELAIN INLAYS.

The pigments most commonly used in the manufacture of dental porcelains are precipitated gold and platinum, purple of Cassius and the oxids of gold, titanium, manganese, cobalt, iron, uranium, silver and zinc. The colors produced by the use of these pigments in varying proportions are red, yellow, blue, green, brown and gray. Red is not used extensively by inlay workers. All gum enamel frits are tints of red. It may be used in the manufacture of browns and grays, also to build the gingival portion of many inlays.

Yellow.—Yellow is the most important color for the porcelain worker. It is used to form the body of most inlays; it adds brilliancy to the browns or grays when combined with them. Yellows of a greenish hue tend to lose their luminosity in yellow light. Two yellows, in their deeper tones, may match each other perfectly, but when diluted to give lighter tints may differ quite widely. One may be of a greenish hue, while the other may tend toward a grayish.

Blue.—This color is used to build the body of the incisal or occlusal portion of inlays for those teeth with blue incisal edges or cusps. There is a variation in tone from greenish blues to those of a reddish hue. Blues of a greenish hue appear to be more translucent.

Other Colors.—Green is seldom used alone; it may be added to blue to increase its translucency. Browns are used to build the gingival portion of some inlays and for the body of inlays for discolored teeth with a brownish hue. They may be added to yellows to modify them. Grays are used to build the middle and incisal or occlusal portions of many inlays. They are also used to tone yellows and blues.

Shading.—This part of making porcelain inlays is the most difficult to the majority and is an uncertainty with all of us. The problem of shrinkage is an unknown quantity and its

remedy is purely mechanical, but the problem of shading is a combination of various considerations which may be followed most minutely and then the object may be defeated by some detail not always possible to avoid, and this most common defect is caused by the opaque cements. The most experienced have this discouragement, but it can be decreased by using a variety of shades and matching carefully. We have and can mix an almost endless variety of porcelain shades, but this is only a part of the requirement, for position and tooth density must also be considered, together with quantity of porcelain to be fused. There is also the additional difficulty of correct fusing to reproduce the desired shade.

Overfusing is the cause of more shade failures than any other, but practice will largely obviate this trouble as in other difficulties. The most careful directions are inadequate as compared with actual demonstrations. After all has been said, there is still the possibility of failure to fully appreciate this phase of the work, because this part of it appeals directly to the artistic sense, and can only be comprehended through observation and experience.

The difficulty of obtaining colors that accurately match the natural teeth is a part of inlay work which will always be perplexing, for the teeth are largely composed of organic matter, while the material used for repair is an inorganic composition, differing in texture and density. When selecting the colors for inlays note the various shades of the natural tooth, for frequently there are three or more. If the tooth is vital these hues have a distinction which is lost after devitalization, thus increasing the difficulties of matching; but if the variant and uncertain hues of the pulpless tooth are once reproduced in an inlay the subsequent change attending the cementation is not so marked because of the pulpless tooth opacity.

Position of the inlay is a factor which largely governs the shade, for the shadow problem is an incident which forces consideration also. This is particularly evident in proximal cavities and is remedied to some extent by making the inlay a shade lighter, and is also controlled by the size of the inlay. A lateral incisor being much smaller than a cuspid must be

treated accordingly, for the density of the latter is much greater and will allow a deeper shade. Labial inlays, particularly bordering the gingival line, can safely be made a shade deeper; but due consideration must be given to depth, for if very shallow the porcelain should be of greater density and thus overcome the cement change. Inlays of this kind are improved in texture by using nearly all base body, and in some instances low-fusing porcelain is more effective because of its less translucency.

With one exception all inlay porcelains are of the same texture from base to finish, which is an advantage in the instance just cited; but the introduction of a combination consisting of a basal body to be covered by enamels was a step toward procuring more natural results in the majority of cases. This basal body represents the dentin, which in turn is covered by a more transparent material representing the enamel, thus enabling the operator to blend the various hues of shade of which the natural tooth is composed, thereby producing a translucent effect not possible by one dense porcelain no matter how expert the operator may be.

The restoration of an incisal tip or corner is an operation that requires much practice and artistic skill, for its prominence demands perfect shading and adaptation. An operation of this character, while testing the ability to match shades, has the advantage of not being affected by the cement line because of greater proportion or volume of porcelain. However, perfection must not be expected because there is always the difference between the natural translucency of tooth structure and the unavoidable density of porcelain, which in certain positions is more noticeable by the deflection of light rays.

A common mistake in shading is in not considering the difference between the volume of shade exposed on the porcelain shade guide and the quantity required to fill the cavity.

The mixing of several shades to gain the one desired is largely one of intuition, because the shade cannot be known until the porcelain is properly fused. This difficulty is unfortunate, but cannot be avoided, as all porcelain powders are practically the same, with the exception of a few extreme

shades, and herein lies the difference between the porcelain artist and the painter whose pigments are mixed and the desired shade revealed to the eye by simple manipulation.

CEMENTS AND MANIPULATION.

It is generally conceded by porcelain operators that while a material of this kind is almost an ideal filling, it falls short of the ideal because we are forced to use as an attachment a substance detrimental to that aim which we have in view, namely, the absolutely invisible restoration of tooth form.

What cement do you use? is an ever-present query in all porcelain discussion, for when there is a failure the cement is generally blamed for it. This is a natural deduction when it is considered that a student in porcelain is more familiar with cement than with other parts of the operation, and if there is a failure it is a natural supposition that it is caused by poor material. A cement must be tenacious, finely ground, and not quick setting, and of a quality most likely to resist moisture when setting, for it is not always possible to keep the work free from dampness during that important stage. There are many cements manufactured that have these requirements, and, like other materials with similar merits, the choice rests with the operator. They all have the same disadvantage, viz., opacity, and the perfect porcelain operation cannot be claimed until the attaching medium is transparent or nearly so. A common trouble is mixing cement too thick, thus preventing proper seating of inlay, which makes the joint conspicuous and unfinished. When this occurs, quickly remove the cement and cleanse every part of the inlay thoroughly, replacing with a thinner mixed material.

As already stated a filling of porcelain can be made perfect in shape and shade and the texture may approximate tooth substance in a highly satisfactory manner; but immediately upon attaching it permanently the shade is changed through the differences between the three substances, all of different density, which come in close contact, namely, porcelain, cement and tooth. The cement being the chief point of

difficulty, it is important that its objectionable features should be reduced to the minimum.

It is a poor cement that is not at least preservative. Many cements are similar in manipulative qualities with the difference of slow, medium and quick-setting tendencies. Some are coarse and others are fine, and a few have a combination of many good qualities, but with that tendency to "pack" under pressure which causes annoyance to porcelain workers. A cement closely ground, of clear color and medium to slow setting, having the maximum adhesiveness with the least amount of powder, is what is recommended for a successful operation; add to this one that has the greatest amount of resistance to moisture during what is usually called the "setting" period.

Shading a cement to match the tooth, or to lighten or darken either the porcelain or tooth, or both, is quite bothersome at times and disappointing also. It is of considerable assistance to mix pellets of cement of a variety of shades and mount them in the most convenient manner to allow of comparison, and in that way saving much time and avoiding guesswork. Whenever possible use the deepest yellow because pure calcined oxid of zinc is quite yellow, and its chemical combination with phosphoric acid is more complete than when otherwise changed.

For instance a white or very light yellow is made so by oxid of zinc, thus reducing the chemical union to a marked degree; and the same applies to darker shades, such as browns, blues and grays. This is a point of some advantage in setting crowns and bridges, or whenever tenacity is a first requirement; for such purposes use the purest yellow cement just as it comes from the bolting cloth without the slightest manipulation whatever.

Some years ago there was invented by Dr. C. H. Land a material in the form of a paste or paint which is applied to that part of the porcelain intended for attachment, and which is then subjected to heat of about 2000° F., thus giving the porcelain a semivitrified surface composed of a substance which has a chemical affinity for cement and acts as a medium of attachment. This promises to be of most

important assistance in many cases wherein strength is of first consideration. This material is called "media," and is made for both high- and low-fusing porcelain; it will also be found of value in repairing facings of broken crowns and bridges. It is claimed that by its use added strength is given to porcelain, enabling the operator to extend the field of porcelain work to all masticating surfaces or other places where the strain is too great to use porcelain with cement as the only attachment. I am prompted to mention this material at this time, because I am interested in any and everything pertaining to this branch of dentistry that may seem to promote its advancement, and also because I have privately and publicly made tests sufficient to give confidence in its merit and convince me that its use will be general when once its advantages are known.

Undercuts for Retentive Purposes.—Undercuts are not necessary in the tooth cavities, but they are imperative in the filling for retentive purposes and are made with diamond or hard rubber and corundum disks. The latter are made in such a variety of shapes and sizes that I think they are all that can be desired, for their cutting power is equal to any other and the cost very moderate. Some dentists claim that cuts in the porcelain are not necessary, as hydrofluoric acid will roughen the surface sufficiently to stand any strain and that cutting of porcelain is a source of weakness which is not occasioned by using acid. This may be so if the undercuts are made too near a wearing surface, but again experience is our test, and that is much in favor of undercuts. In very small inlays acid can be used to advantage, and it cannot be a disadvantage to use it in connection with undercuts; but to stake your trust entirely on the use of acid is a mistake which will cause trouble.

The method of using it on very small inlays where an undercut is impossible is to soften the surface of a piece of beeswax or paraffin and embed the porcelain, taking care not to have edges exposed, then drop a little acid on the exposed surface and allow it to act for a few minutes; then wash off with a water syringe.

Placing the porcelain in position is a part of this work that

requires extreme care and frequently great patience. Care should be observed that the cavity is thoroughly dry before the insertion of the filling and kept dry until the cement is hard enough to resist moisture. Use alcohol freely in the cavity and on the filling; then apply hot air and mix the cement to a creamy consistence; this when applied to the cavity walls almost grows there as the affinity is so great. As quickly as possible place the inlay and gently press into position and hold until it becomes fixed. The excess of cement is removed by a small piece of firm spunk. In proximal work I use waxed silk, drawn over the surface gently working from center to edges, for in this way excess cement is easily taken from between the teeth, which, if left until hardened, may loosen the filling in removing it. It is risky to try to get everything clean; much better to leave the surfaces a little smeary. For protection against saliva the parts should be covered with a little hot paraffin. Rubber and sandarac varnish and chloro-percha are used by some, but paraffin is the favorite because it is cleaner and has a blending effect, which is quite an advantage at that time, for the tooth is lighter by the drying process and the cement has given the porcelain a more opaque appearance; so it is just as well that the patient should not be allowed to inspect the result too closely just after the insertion of the filling. The time to show it to the patient is before the tooth is dried; put the filling in its place and allow the saliva to be the cement for the time being. Frequently it is never seen to better advantage.

At a subsequent sitting the edges are touched with a stone and the most expert operator will find this necessary, for the tongue will find an edge if he cannot. Fortunately for us, after a time there is a blending of the porcelain and tooth that is quite gratifying; but it is better to explain this to the patient, for some people are unreasonable enough to expect perfect results with very imperfect materials. The difficulties besetting a porcelain worker are growing less each year, because when a thing is demanded and that demand comes through confidence, then allowances are made which will assist the operator, providing he has skill and is tactful.

Cementation of Inlays with Silicate Cements.—The attachment of inlays with silicate cement greatly adds to the beauty and completeness of the inlay, but its use is governed by certain conditions. This cement is not so adhesive to the tooth structure as oxyphosphate, therefore a decided undercut in the cavity is absolutely necessary. The silicate cement will adhere to the porcelain with small assistance and apparently has all the adhesiveness necessary in the cavity, but after a time, probably a few months, this tenacity is diminished, rendering an undercut a necessity. This condition is a reversal of the qualities of the older cements and may be remedied in the future, thereby overcoming the "cement line" objection. A porcelain inlay well shaded and adapted, then attached with a silicate cement, is a perfect restoration.

CHAPTER III.

PORCELAIN CROWNS.

An artistic substitute for the natural tooth is always desirable, but success will depend largely upon the operator's ability of discrimination. There is such a variety of conditions to contend with that any practitioner who confines himself to a very limited assortment of operations is handicapped as compared to one who has a variety of choice and the ability to make the application.

The porcelain worker has the opportunity of always leading in this respect, because with practice he can always "fit the case" and perform operations that come under the head of "Special Work."

The various crowns at the disposal of the porcelain worker are carved bicuspids and molars, with or without bands, all-porcelain pin crowns, cup crowns, tube and post crowns and various jacket forms. Along with this assortment of crowns are the operations of repairing and adding porcelain to manufactured crowns or tooth facings, using gum enamel to imitate the natural gum, etc. The application of porcelain to bridges in many instances is very desirable; in fact, the ability of the operator is the only limit to the use of porcelain in dental operations.

THE BANDED POST CROWN.

After a long experience with the use of the post and tube crowns it has been noted that in some instances under unusual strain the screw post will become unstable and allow a movement, eventually causing the loss of the crown. To overcome this possibility a band or ferrule has been added, ensuring a security which increases the value without any detriment to its appearance.

In recent years I have been using a small nut on the post, turning it until it jams the root end tightly and effectually resisting any tendency of movement of that part of the post within the root. The application of this nut is very simple and the added retention is most valuable.

A banded post crown must be superior to any other crown which depends entirely upon the root canal for a foundation, because the retentive part is only a screw fitting the interior of the root; whereas if the top of the root is protected by a cap, splitting and a tendency to twisting is prevented, and, finally, the breaking of the crown does not necessarily interfere with the foundation and it can be repaired without difficulty.

FIG. 88

FIG. 89

FIG. 90

FIG. 91

FIG. 92

The preparation of the root is similar to that for any banded pin crown and the platinum cap is made and fitted in the same manner, the gauge of the material being No. 33. When the cap is ready for the next step it will appear as shown in Fig. 88, where it is represented as in position on the root. The canal is enlarged and drilled to the depth required, the instrument used corresponding with the size of post that it is intended to employ; after which the tap is used, which gives accurate position for the post. Then remove the cap and screw in the post after applying thin cement to the end which is to be embedded. Enlarge the drill hole in the cap so that it easily fits the post and the tube, which are made the same as already described, but with a heavier platinum than the foil recommended for the other crown. The size should be about 36, because it must resist the pressure of the cap against its surface, and if the tube is too thin it will jam against the screw-post and

resist easy withdrawal for soldering. The post being placed in the root and firmly set with cement, the tube is placed over the exposed end of the screw and then the root cap is placed over the whole affair and will appear as in Fig. 89. If the cap and tube fit each other accurately it is possible to draw them off together and solder without using wax and investment. The soldering is done from the inside joint of the tube and cap and with a very small amount of pure gold.

When the two pieces are attached they are put on the root as in Fig. 89 and a tooth facing is chosen which may be either with pins or without; if with pins they are soldered to the tube, as shown in Fig. 90. If a plain veneer is used it is embedded in place by the paste porcelain as already spoken of and as shown in Fig. 91. By this means much time can be saved and the strength seems sufficient. After the second baking and the final finish the crown will appear as in Fig. 92. In appearance it is natural and it possesses a durability and adaptability that can be claimed for only a few crowns. In making this crown for bicuspids and molars the cup principle can be applied quite as readily as if the foundation were a dowel.

This banded post crown is just as easily made as porcelain and platinum and can be substituted for a Richmond, either individually or as a bridge anchorage. While soldering the tube should be filled with powdered asbestos and whiting, thereby preventing the gold from running on the inner surface.

In special cases when the root has resisted treatment and when I have not had perfect confidence that it will not prove troublesome, I have used a hollow post, allowing free access to the apex and giving such control of the conditions as to lead eventually to absolute cure.

THE CUP CROWN.

This crown is made with or without a dowel, as the case demands, and the root is prepared as for any banded crown; but when no dowel is used a little more tooth tissue should be left for retention at the palatal aspect (Fig. 93). A

platinum band, lapped at the joint, with plenty of width, is made to fit the root accurately and festooned so that it will not lacerate. While in position on the root, mark with a pointed instrument on the inside of the platinum band the line of the root; also the gum line on the outside of the band as shown in Fig. 94. With a pair of fine-pointed scissors cut the buccal half of the band to the line of the gum; place the band on a piece of platinum, No. 30 or 31. Mark the shape of the band on it for the palatal two-thirds, trim and file accurately to the mark and fit it to the line of the band. Then tack it in position with platinum or pure gold solder, after which the remaining part of the apron may be pressed down to the buccal portion of the band and the solder made to complete its course around the band (Fig. 95).

FIG. 93

FIG. 94

FIG. 95

FIG. 96

Trim off any surplus and file the buccal edge rounding, which allows for a better extension of porcelain on the band. If a dowel is to be used it can be adjusted and soldered in its proper relation at this stage. The extended portion of the band is contoured if necessary and the crown proceeded with along the same lines as others of similar kind. If a dowel is used the pins of the facing are soldered to it (Fig. 96); if no dowel is employed the pins are bent down and soldered to the cap or floor of the cup. The band projecting above the face of the root forms a "cup," in which the porcelain has its base and gives to it additional strength required for mastication, so that the liability of fracturing the porcelain is reduced to a minimum.

The facings used for such crowns should be of American manufacture when using a high-fusing body, because the tex-

ture is very similar and the union more positive. A note is made of this because many dentists use veneers of English manufacture, overlooking the fact that there is great difference in the fusing-point of the two materials, and that the shade of the facing is often changed by the fusing of added porcelain. English teeth can be used only with porcelain body of the same character, and additional care must be given to avoid overheating. Porcelain crowns of this style can be used to serve as abutments for gold bridges, as they have a soldering surface giving sufficient strength in the majority of cases.

THE POST CROWN.

This crown was invented by Dr. C. H. Land, of Detroit, and is recommended for its simplicity and because it can be quickly made. It presents a natural appearance and has surprising strength, chiefly because the foundation is a screw-post tapped into the root, thereby affording a secure foundation, not always possible to obtain with a pin crown, especially in cases where the root canal is enlarged and the walls are of doubtful strength. By using this screw foundation I have had the satisfaction of saving numbers of roots which otherwise would have been lost and of obtaining from them excellent service for many years. To gain the best results one should possess the How screw-post outfit, which consists of a drill for hand or engine use, a tap and a set with which to put the screw in place. These little appliances are not new, for they have been on the market for many years, but comparatively few dentists know of their value, not only for crown work but for making a strong foundation in any broken-down tooth.

The preparation of the root should be similar to that for pin crowns. Grind the labial or buccal edge well under the free margin of the gum, then enlarge the canal by means of the tap drill and then the tap itself. It is well to mention that there are three sizes of these instruments, viz.: A, AA, and B, the latter being the largest of the three and the most used size for general work; although for very small roots A or AA would be a safer size. The root being ready for the

post, insert it with thin cement, thus ensuring a perfect adaptation. If the root walls are thin and hollow from the margins, pack amalgam in the excess of soft cement and level with the edges, thereby increasing the solidity. The screw post is shown in position in Fig. 97.

The next requirement is a hood which will cover the post and face of the root. This is made by taking a small square of thin platinum of the same thickness as that used for inlay work, or slightly heavier, will not be a disadvantage; roll this around a duplicate post, as shown in Fig. 98. Then cut a square of platinum large enough to cover the end of the root, punch a hole in the center with any round-pointed instrument the same size as the screw, although the most accurate and simplest way is to use the rubber-dam punch (Fig. 99),

Fig. 97

Fig. 98

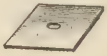


Fig. 99

Fig. 100

then push the metal square over the end of the screw which has the tube on it and gently force to the other end, which gives you the two pieces together, as seen in Fig. 100. Pull the post away and solder the tube and square together on the under side. In this manner the most difficult part of the crown is made, and in less time than it takes to describe it on paper. It is then placed on the root and burnished until the outline of the root edge is plain. The surplus is cut away nearly to the line, and any excess of the tube cut off while in position, giving a form like Fig. 97. A flat back tooth is fitted so that the pins are on each side of tube and soldering is not necessary. This is put in position in the mouth and held by sticky porcelain paste, and withdrawn with a pair of pliers, catching the tube through the porcelain (Fig. 101). Place on the tray and carefully dry in front of the furnace, then fuse and cool in the tempering muffle.

Before trying it in its position, pull the edges of the platinum slightly away from the porcelain, so that when the crown is placed the edges will hug the root closely and allow room to force a burnisher blade between and get a perfect outline. Porcelain is added and the crown fused a second time, which gives it proper shade and finish, and is then ready for permanent setting after the platinum is peeled from the base, leaving the tube intact. When finished the crown appears as shown in Fig. 102. With care a joint can be made equal to that of an inlay, and the general appearance of the crown is one of pleasing neatness. Using a veneer without pins saves time and lessens chances of checking. This crown can be applied to any tooth in the mouth, but foundations for molars should have two posts.

FIG. 101

FIG. 102

Every dentist has experienced the difficulty of repairing a broken dowel crown when the pin is firmly established in the root, and its removal would consume much time and probably endanger the root by perforation. In such cases the principle upon which this crown is constructed can be applied to great advantage and its durability equal to the original substitute. The crown is also readily adapted to cases where the gum line is uneven.

JACKET CROWNS.

This crown derives its name from the fact that it envelops a portion of the natural crown and thereby retains the original strength of the tooth to a greater degree than if the crown were trimmed to the gum margin.

This class of work is not new; in fact, it is more than thirty years since it was first used and given to the profession. To be accurate, it was in the year 1886 that Dr. Land described this crown as a "new method of covering teeth with porcelain." In later years the method has changed, until at the present time we have practically three kinds that can be properly placed under the term "jacket crown."

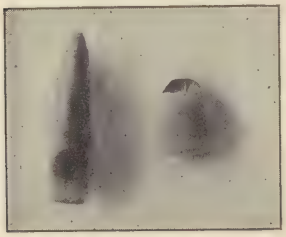


FIG. 103

FIG. 104

The original crown of this class consisted of a frame or sheath of platinum covering the prepared tooth, as shown in Fig. 103, with a porcelain veneer fused to the labial surface, leaving the lingual surface exposed, the platinum and the whole shell being cemented to place. The second type of jacket crown requires greater cutting of the natural tooth, because the lingual surface is also porcelain. The frame is of thin foil, which is entirely removed, leaving an all-porcelain shell (Fig. 104). The third type of this crown is of more recent production, and Dr. Land calls it the "overlap," because it overlaps the tooth mesially and distally without covering the lingual portion (Fig. 105). This crown is also made on a foil base and the metal stripped from it before the crown is cemented into place. The advantage of this crown over that

shown in Fig. 104 lies in the fact that it is not necessary to cut the tooth lingually, affording an opportunity for easy access to the pulp should occasion arise.

The various forms are all of the highest order of dental reparation or substitution, but the original jacket crown is my favorite, because it has practically no limitation. It is sometimes criticized as being bulky, and it is claimed that the shade cannot be controlled because of the platinum background, but in this work, as in other dental operations, much depends on the operator. No doubt the work of twenty years ago or even of more recent date deserved this criticism, but most of it is still in use and acceptable in appearance. Hundreds of these crowns were placed in almost hopeless cases where no other substitute was possible, and they are holding

FIG. 105

their own with more perfect neighbors. Teeth with vital pulps, devitalized teeth, fractured roots, torsion teeth, "peg" or "rice" teeth, bridge abutments, deformities of all kinds, including regulating, constitute the field for this kind of crown.

Bicuspids, molars and lower incisors are worth mentioning also, for when the lower incisors are bad they are generally very bad, and what kind of a pin crown can be used there with satisfaction? The roots are narrow and too small for any degree of enlargement of the canal without danger of perforation, yet the position requires great strength in the substitute, for the leverage is enormous for a small tooth. The application of a jacket crown is just as satisfactory in these instances as in any other place in the mouth.

How much of this field will the other jacket crowns cover? —for they are practically alike in their application. They are useful just in proportion to the amount of tooth substance which is left to be covered. They are dependent upon a considerable amount of the original structure, and if that is present there is an opportunity of making a natural appearing and strong crown unsurpassed by any other we know of. They are particularly adapted to covering darkened teeth which have been devitalized, and the overlap crown designed by me, as shown in Fig. 105 has the advantage of necessitating less cutting of the natural tooth. The lingual surface is open and therefore reduces bulk and allows access in case of necessity for treatment. These crowns must be used individually; therefore they have no value as a bridge abutment and cannot be united for the strength which is sometimes required when the roots are affected by pyorrhea.

The skill required in making this crown consists largely in the fusing of the porcelain and strict attention to technical detail; but any dentist with a fair amount of experience in making inlays or using porcelain may expect good results and increase his field of operations extensively.

The shell, tube or hollow crowns have the advantage of being stronger than any pin or post crown, because there is less reduction of the original resisting surface to contact. The substitution of the original crown generally means the reduction of the fulcrum to a given point, which is at the cervical line, therefore a jacket crown must be stronger, for it does not create a weakness by restitution.

These crowns being shells, there is no possible chance of reducing the value of the foundation in case of breakage, and the repairing is a much simpler operation than is the repairing of any other crown. This statement applies particularly to the platinum base jacket crown.

BICUSPID JACKET CROWNS.

The decay and general breaking down of bicuspids when the anterior teeth are in fair condition produces defects so

conspicuous that restoration of a natural appearance is of the utmost importance. Still, in the majority of cases, the value of any operation upon such teeth is decreased in proportion as strength is sacrificed to beauty, because the position of the tooth is such that use is a chief requisite. Hence, the value of a crown that combines naturalness of appearance with great strength and with the minimum loss of tooth-structure must be generally recognized; and if, in addition, such a crown requires no extraordinary or special skill for its construction we have a combination of advantages that cannot fail to appeal to all who desire to practice the highest dental art.

In addition to the susceptibility of bicuspids to decay and discoloration, their position in the arch enforces a use and strain which makes a hollow metal cap most effective; hence, a metal cap has been and is one of the chief methods of repair. In patients to whom this is objectionable, the complete loss of the natural crown and a pin substitute is the only alternative, unless the jacket crown is employed.

The bicuspid porcelain jacket is not generally used, but by a few it has been employed for many years and with such success that I do not hesitate to claim for it a superiority over all other forms of artificial crowns.

There are two kinds of jacket bicuspid crowns, differing little in construction, but each having its particular field of usefulness. The first described can be used either for a long or short bite, whether the space be narrow or wide, and for either an upper or lower denture. The preparation of the crown or remainder of the crown (oftener the latter) is very similar to that for a gold shell, with the exception that the buccal surface must be ground to allow for the porcelain, as shown in Fig. 106. The circumference is taken with wire and the band cut from platinum plate, gauge 32, allowing for the lap-joint, always using pure gold as solder, as in other porcelain jacket crowns already described. Solder the joint with a small quantity of pure gold, then cut the edge to conform to the gum margin and fit the root as shown in Fig. 107. Place the joint of platinum on the lingual side. If found to be a little large, compress the edge with bent-nose

pliers; but in any case the fitting must be corrected before adding porcelain. The band is then marked to be cut almost even with the tooth crown, or at least close enough to be free of the opposing tooth. Solder a piece of iridioplatinum, of same gauge or heavier if desired, to the inner half of the band, leaving the front half free, as in Fig. 108. Cut and trim the surface until it resembles an ordinary cap with half-soldered top. Then grind the face of the cap intended for the reception of the veneer (Fig. 109). Then with contouring pliers, with beaks like those shown in Fig. 110, contour the front half of the cap, which can thus be made an excellently formed cusp, and will leave the skeleton of metal ready to be fitted and like Fig. 111 in appearance. With a coarse, pointed or serrated instrument press and indentate the thin ground front, thus making it lie close to the tooth and

Fig. 106

Fig. 107

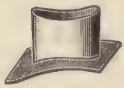


Fig. 108

Fig. 109

giving a better surface for porcelain. Choose a veneer of proper shade and approximate size and grind until it fairly fits the space intended for it. Mix porcelain and pack into every little space, and press the veneer into position, and then draw the whole crown carefully from the tooth, and after the proper precautions fuse in a small furnace. Try it on the tooth again, and if the veneer is too full or too long, grind and polish with sand-paper disks and trust to a second baking for renewal of gloss. Where necessary, more body must, of course, be added, the sides being the place most likely to require it. After the final baking the metal part is polished and the crown is finished and ready for setting (Fig. 112). It is hollow like a gold cap, has clean, hard metal on the grinding surface and a porcelain front to give it a natural appearance. It can be used over a living tooth which is

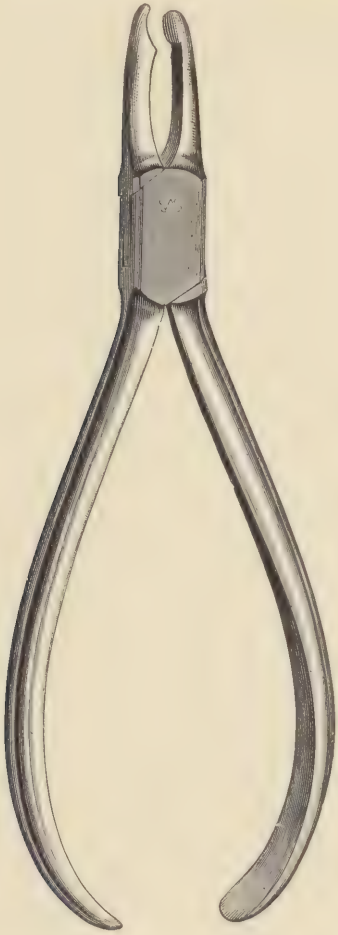


FIG. 110

FIG. 111

FIG. 112

FIG. 113

FIG. 114

easy of access in case treatment is required, and is readily repaired if broken. It is one of the most satisfactory methods for crowning very short teeth with a correspondingly short bite, so often encountered and so bothersome to the operator.

Another crown especially adapted to built-up roots or badly broken teeth where there is a fair length of bite is made in the following manner: The measurement is taken in the same way and the procedure is the same in making and fitting the band. As porcelain is used for the grinding surface no metal is to be soldered on that surface. After the band is fitted the face is ground to allow for the veneer (Fig. 113). Remove the band and burnish platinum foil over the end of the root or portion of tooth to be crowned and replace the band. Porcelain paste is then packed over the whole surface even with edges of the band. A veneer is put into position, or the face may be carved, and the whole crown is drawn and placed in the furnace ready for fusing. After the first baking it is placed on the root and the bite noted, and is then finished by making cusps of porcelain and fusing the second time. When completed the outward appearance of the crown is as represented by Fig. 114. The clear portion represents the platinum and the dark lines the porcelain. The platinum foil is still on the inside. It is optional whether to remove or leave it, as its only purpose was to form a matrix for the porcelain.

This crown is exceptionally strong and natural in appearance and is easily made and applied. I have used it for several years on the most umpromising roots possible, and have yet to report the first failure. I have also had splendid success in joining first and second bicuspids together, where both roots have been weak, by soldering the bands together before the porcelain is added, and it is very pleasant to note what satisfactory work such wrecks can be made to do if carefully treated. This form of crown makes an excellent abutment for a gold bridge, as well as for an all-porcelain bridge, and is a wonderful help in small extensions where a gold cap is undesirable, for there is no difficulty in soldering one or several teeth if properly invested and heated. The crown last described is recommended for use whenever there is

sufficient room for porcelain on the grinding surface, but that is not always obtainable. For a short crown a good expedient is to combine the two methods by shortening the metal on the grinding surface, as shown in Figs. 111 and 112, and allowing the veneer to extend beyond it, and adding porcelain so that the outer cusp will be entirely porcelain and the inner part metal, to withstand the contact of the occluding tooth, thus making the crown more like the cuspid jacket. If the porcelain is of good quality and well baked it has a great resisting force and it is not easily fractured.

The directions for repairing these bicuspid crowns are the same as applied to those of the anterior teeth, which will be described further on in this chapter. It is also well to note that this class of work is made entirely in the mouth, because, for reasons unnecessary to explain, no bending or fitting can be done after it is finished, unless it be by the use of contouring pliers on the free platinum edge, care being taken not to impinge on the porcelain surface. These crowns can be applied to molar restorations with equal effectiveness.

THE PLATINUM BASE CROWN.

The platinum base crown (Fig. 118) is made as follows: The tooth or the remaining portion of the tooth is ground wedge shape, more labially than lingually, because the porcelain requires more room so that it will be in line with the adjoining teeth, while the lingual or palatine portion has only the platinum to be allowed for, so that the occluding teeth do not strike with any wearing force. The tip is cut off about one-fourth and the enamel line is trimmed at the gum margin with enamel scalers or Evans's root trimmers (Fig. 115). These efficient instruments are used on the engine and assist in getting a smooth surface without unduly lacerating the gums.

The grinding should be done with good stones of medium grit, using water very freely, and the simplest instrument for this purpose is the glass medicine dropper, although a water syringe in the hands of an assistant is a convenience.

The tooth when trimmed and ready for the jacket will appear as in Fig. 116. Thin disks are used to grind between the teeth making room for the band, also to slightly taper the tooth mesially and distally; but frequently cavities on these surfaces will obviate the necessity for much grinding. The next step is to measure the root neck just the same as for a gold shell. Instead of gold, platinum No. 33 or 34 is used and the joints are lapped. Solder with pure gold, using the least amount possible. Gold and platinum solder is preferable and can be used with the ordinary blow-pipe if the metal is cut in very small pieces. When the band or tube is made it

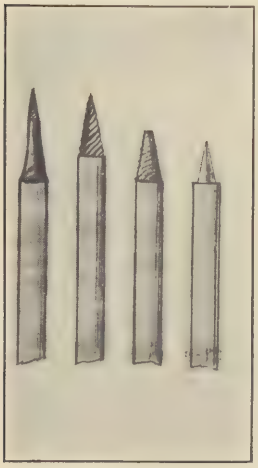


Fig. 115

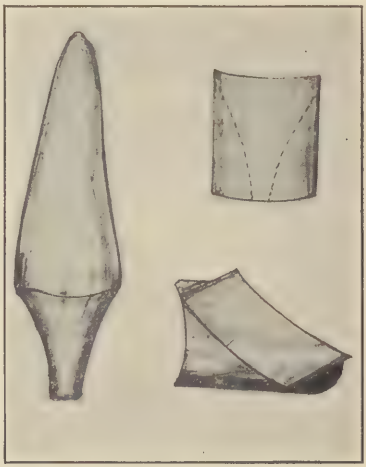


Fig. 116

is fitted to the tooth and the lingual and labial outlines of the adjacent teeth are marked on the tube as a guide to trim those portions so that they approximately fit the wedge shape of the prepared tooth (Fig. 116).

Next give attention to the lingual surface which is ground to the dotted lines on a lathe and then reinforced with platinum or iridioplatinum of the same gauge Fig. 116. Melt a little solder on the platinum square and then place it in the same position as the cut shows. The solder will show a

shadow as it melts and is a guide as to the quantity and position of the gold. This portion may be cut out, but not to the exact marked line, because a broad surface attachment is very desirable. The edges of projecting platinum are then ground even with the tube surface (Fig. 117), and then the labial or face side of the tube is ground thin to the marked line. This is the most important part of the work and probably the most difficult, for the reason that we require a surface sufficiently thin to burnish to the natural tooth, and if the part is torn or ground through it lessens the porcelain attachment proportionately.

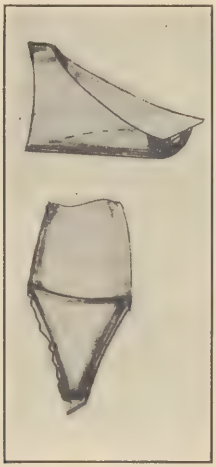


FIG. 117

FIG. 118

This being done and the tube fitted on the tooth it will resemble Fig. 117, which only shows the outline of the corrugated front. The tongue on the incisal edge may be noted, for this is the secret strength of the crown and cannot be seen after it is made. Press the front of metal to place with a blunt instrument, with the object in view of making it irregular and better adapted to secure porcelain, and the little tip of metal on the lower edge is made by pressing it against a revolving stone, which turns it and gives it a thin

edge in the same movement. After the metal cap is made, and before fitting, place it under the blow-pipe and anneal it, also removing any grindings or foreign material that may be present.

The crown is now ready for the porcelain front, which is a thin veneer made for the purpose. This veneer or facing is ground thin and fitted approximately and is attached by means of porcelain body mixed stiff with mixing fluid, which is forced into every part offering attachment, and especially between the tooth tip and the metal point, also into any depression caused by cavities. The veneer is put into position and tapped into place, and the whole is removed with pliers, the excess of porcelain removed and then dried carefully, face down, on a tray in front of the muffle. The crown is now gradually pushed into the furnace and the heat raised to the fusing-point; then placed in a cooling muffle until thoroughly cold. The crown is then tried on, and if too full cut from the face and add more body where required and finish, placing the crown on the tray, face up after the front has been attached, heating and cooling carefully as before. The platinum is polished with sand-paper disks and the crown permanently placed, with moderately thin cement, and will appear as in Fig. 118. If the surface of the porcelain has been ground with a stone to reduce the bulk or change its form, it should be thoroughly disked with clean sand-paper disks before the final fusing.

One of the important considerations in making this crown is to note the bite, not because another crown would give better results in certain cases, but because the occluding teeth will be a guide in the making, for certain changes are made in form and material that are of material value. For instance, this crown is described as being made of platinum, and generally that is the metal employed; but there are places in which its combination with iridioplatinum becomes advantageous and sometimes again the whole metal part is made of iridioplatinum. This harder metal is used on the palatine surface whenever there is very hard contact or a liability to unusual wear, as in a case of a "close bite." When the incisal edge is in direct contact it is advisable to carry

the metal to the edge, bending it at the cutting edge to take the force of the bite and having the porcelain anchorage entirely on the inside. In fact, many follow this procedure in all cases, but the porcelain tip is equal in strength and neater in appearance (Fig. 119).

It is claimed by some dentists that it is an advantage to have the whole metal portion iridioplatinum, as its stiffness may allow the use of a lighter gauge. This is true when the work is applied to lower incisors, because of their usual

Fig. 119

closeness, but this combination metal is very intractable and brittle. Even with much experience it is difficult to grind it thin without breaking and its harshness prevents neat adaptation, as compared with pure platinum. The use of all iridioplatinum is advised if the crown is to serve as an abutment either for a porcelain or a combination gold bridge. It is not generally known that jacket crowns of this type can be used in connection with a gold bridge. This, however, is recommended, for they can be invested and soldered regardless of the porcelain attachment.

REPAIRING A JACKET CROWN.

The repair most likely to be needed is re-attaching a veneer. This, if not well attached, generally comes free from the metal, but if the metal tears away with it a new crown must be made. If the framework is intact and firm in place, loosen all the free edges with a thin, sharp, flat instrument, getting out the cement as much as possible and then use an old scaling instrument as a hook at the neck and in many cases the frame will come away, and with a little straightening be as good as ever. Sometimes a pair of pinchers nipping the free point of the platinum will draw it off when other means fail. When removed, clean all the cement out of it and put under the blow-pipe, making it ready for new porcelain. Stoning the surface will assist in securing better attachment. If the same veneer is used all of the old porcelain should be ground away and put in the front part of the muffle for a few minutes to burn out any impurities; then proceed as if the crown were new. The time usually allowed for this repair is an hour.

An unusual cause making repair necessary is the cutting away of the palatine surface by the occluding teeth. I have had several cases which have required this mending after several years' use and in every case the porcelain was intact. If the crown has worn enough to be easily taken off, clean out the cement, burnish thin platinum or gold-foil on the tooth where the cap has worn through, replace the crown and attach the two with wax; then withdraw them and invest. Solder with twenty- or twenty-two-carat gold and re-cement the crown. It will be none the worse for the repair and will probably last many years longer if ordinary care is given in the soldering process.

Treating of a Root through a Crown.—This jacket crown having a thin metal back, provides a ready means of access to the pulp canal; this is a point in its favor, particularly to those who claim that a crown capped will surely give trouble unless the pulp is devitalized. Using a crown of this description, therefore, will prove that such is not the case, but when treatment is necessary, lessen its difficulties.

The writer's experience has proved conclusively that healthy pulps will live indefinitely with the tooth ground and covered as heretofore described, and that only a small percentage of teeth covered with this crown require treatment from any cause. Of course a degenerated pulp will die and require treatment, and so trouble will occur with treated roots, and provision for their eventual treatment is good practice. The non-sensitiveness of some teeth, particularly those that have had much filling, is very delusive, and frequently every preparation for crowning has been balked by the discovery of a living or putrescent pulp. In some instances the delay caused by the necessary treatment of a mutilated tooth causes serious embarrassment, but the employment of this class of crowns relieves worriment from this cause, for in either instance the tooth can be finished without delay, as treatment of the canal can be resorted to by drilling through the platinum on the palatine surface, the opening being finally finished with amalgam, to match the metal, or with gold if preferred.

Porcelain Veneers.—For several reasons the use of thin porcelain veneers made especially for the work is recommended. They require little change of form, and the shading is more accurate and less liable to change than in a tooth ground for the purpose. As they are inexpensive a considerable number can be kept in stock, which is a convenience and also a saving of time. Plate teeth are frequently employed, and a few contend that there is no disadvantage in their use, and that is true so far as the porcelain is concerned. The disadvantage is that the porcelain tooth must be ground thin and every particle of the pin must be ground away, otherwise there may be a check in baking. Now if the shade is correct before grinding, how is it possible for it to be so afterward when the flat side or ground work of the tooth, which governs the shade, is taken away? To retain the shade the tooth must be ground equally on both sides; this reduces production of shade to guesswork. We all know that grinding is tedious, and if the work is placed in the hands of the laboratory student the chances are that the result will be unsatisfactory. A further consideration is the fact that in

using teeth the various products of different manufacturers act differently in re-fusing. This matters little if the face of the tooth is left intact, but if it is ground and given sufficient heat for re-glazing the result sometimes is different. There is also the further fact that some teeth require so much greater heat to re-gloss than the uniting body requires for correct fusing that the latter has lost much power of attachment in the process. I therefore recommend the use of veneers made for the purpose. They are of all sizes and shades and are arranged in twos, fours or sixes with the addition of bicuspids.

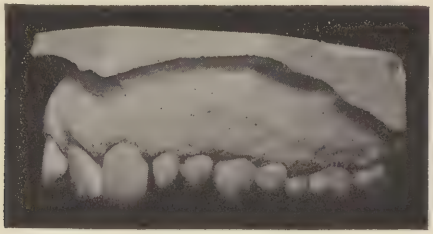


FIG. 120

PRACTICAL CASES OF JACKET CROWN RESTORATIONS.

Figs. 120 and 121 represent the case of a young man of twenty-two years. The central incisors are normal in appearance and are in correct position, but the right lateral incisor is displaced by the canine and is not in alignment with the centrals. The left lateral is malformed, or what is termed a "peg" or "rice" tooth. The deciduous canine on the same side is firmly in position between the lateral and permanent canine. The position of the right canine is held by the deciduous canine, and the second bicuspid is also malformed. A radiograph failed to show the presence of the missing right lateral.

Fig. 122 is the case corrected with jacket crowns. The right canine was devitalized and trimmed sufficiently for a lateral, and the deficiency of space taken up by the enlarged

canine covering the deciduous tooth. The exposed section at the gingival border was covered by a gum enamel inlay.

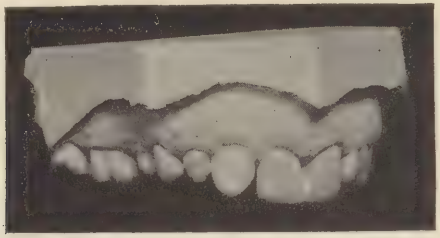


FIG. 121

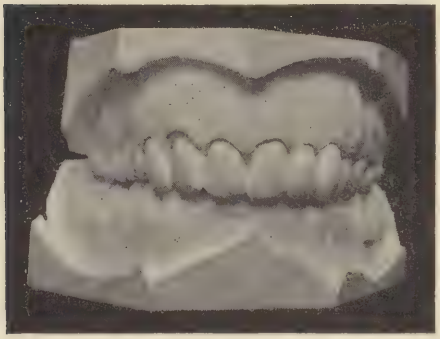


FIG. 122

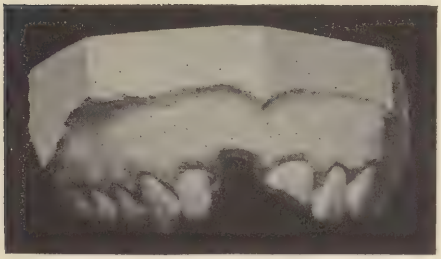


FIG. 123

Fig. 123 represents the case of a young student athlete. The right central had been broken by an accident some years

ago and replaced by a pin crown. A recent blow broke it again and split the root lingually, also breaking the lateral and left central.

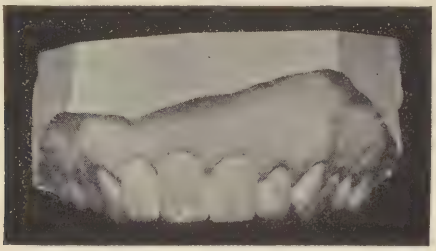


FIG. 124

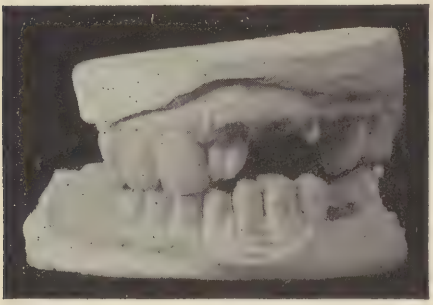


FIG. 125

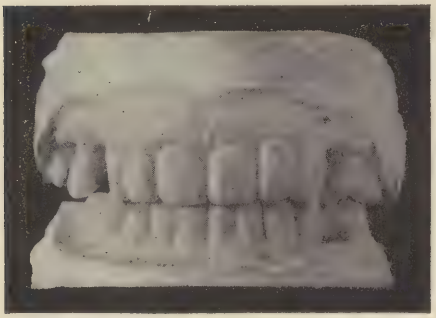


FIG. 126

Fig. 124 shows the case corrected by three jacket crowns. The right central root was reinforced by a screw post and

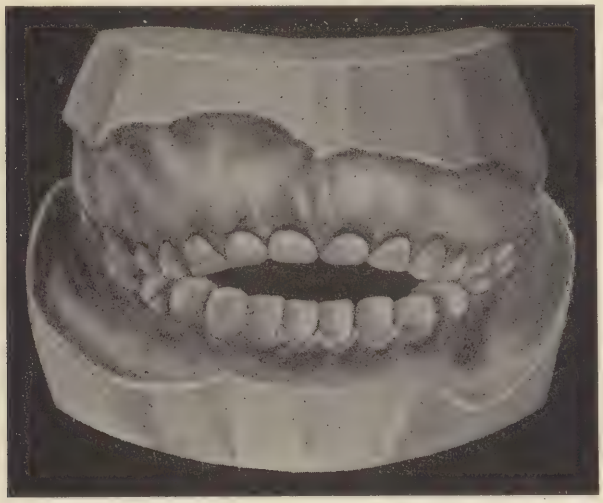


Fig. 127

Fig. 128

amalgam. The platinum frame of the crown was carried well under the gum to the margin of the fracture, and at the present time the tissue is almost in its normal position.

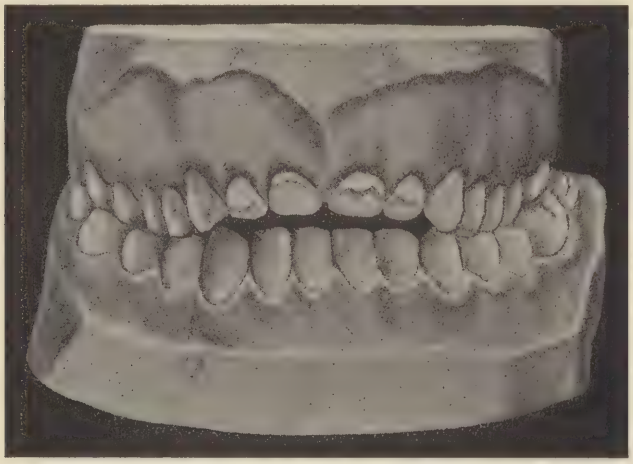


FIG. 129

FIG. 130

Fig. 125 represents the mouth of a retired well-known Philadelphia dentist, who during a severe illness broke the left canine, lateral and central. The pulps being vital and not exposed these teeth were crowned in 1909. The right lateral had been crowned in 1892. This crown was re-cemented and the tooth is apparently as near to normal as when it was first crowned twenty-five years ago (Fig. 126).

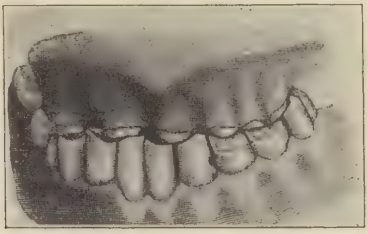


Fig. 131

Fig. 132

RESTORATION OF ERODED TEETH BY MEANS OF THE JACKET CROWN.

Figs. 127 and 128 represent my first and most extensive case of salivary action on the anterior teeth. It was published in the *Dental Cosmos*, 1891, and copied by other magazines, so that many are already acquainted with its peculiar condition and correction.

Fig. 129 shows another case of erosion of four incisors. This is a mouth of a young man, about twenty-two years old, and was corrected by covering with jacket crowns seventeen years ago (Fig. 130).

Fig. 133

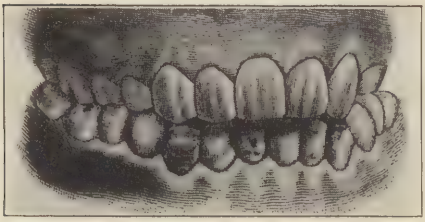


Fig. 134

Fig. 135

Fig. 131 is also one of my early cases, showing extensive abrasion, which was corrected by raising the bite and covering the anterior teeth with jacket crowns. Patient, fifty-nine years old, and used them with comfort for many years (Fig. 132).

Fig. 133 is one of great deformity and presented more difficulties than many others because of irregularity of the teeth. The teeth were first brought to approximately the natural position and then covered without devitalization,

Fig. 136

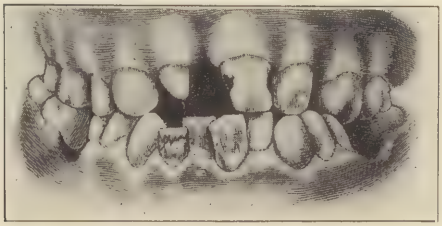


Fig. 137

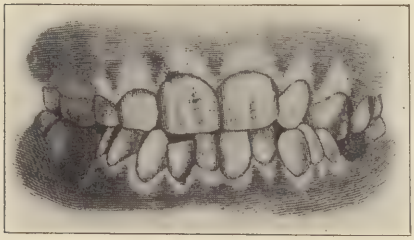


Fig. 138

excepting the right central, which was too prominent to cut without pulp exposure (Fig. 134).

Fig. 135 is a case of a woman of forty-five years and shows extensive wear of the anterior teeth. The bite was raised by bridges and the four anterior teeth covered by crowns (Fig. 136).

Fig. 137 represents a clinical case, youth of nineteen years. Right central extracted when a boy. No left lateral and a peg for the right lateral. Corrected by two centrals with gum added at mesial border; contact to fill space made by extraction (Fig. 138). Date of operation, 1891.

Fig. 139

Fig. 139 is a case of a woman of forty years. Bite raised by bridges and the upper anterior teeth covered with crowns (Fig. 140). No devitalization; operation, 1896.

Fig. 141 shows the unfortunate condition of a girl of seventeen years. The enamel of all her anterior teeth was

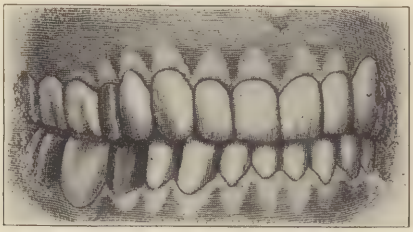


Fig. 140

defective and was much pitted. There is also the additional defect that there is no left lateral. When questioned as to what severe illness she had endured, she lispingly remarked that she had had "everything" and had "always been sick." It will be noted that while the posterior teeth are in contact

the anterior are far apart. This deformity was, no doubt, caused by thumb-sucking, as the teeth were slow in eruption.

FIG. 141

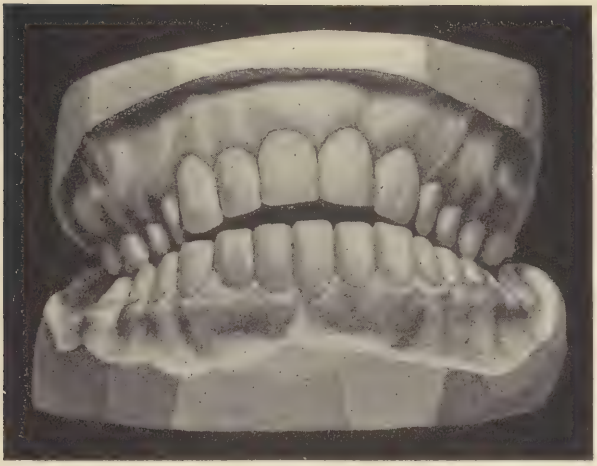


FIG. 142

In this case a complete correction was an impossibility, but the covering of both the upper and lower teeth from the cuspids reduced the space very considerably and the improve-

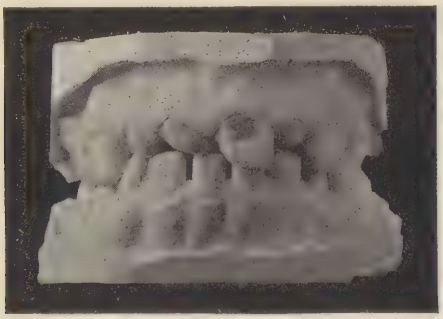


FIG. 143

ment in speech was very marked. This case has shown no change after seventeen years with the exception of treatment of an upper incisor (Fig. 142).

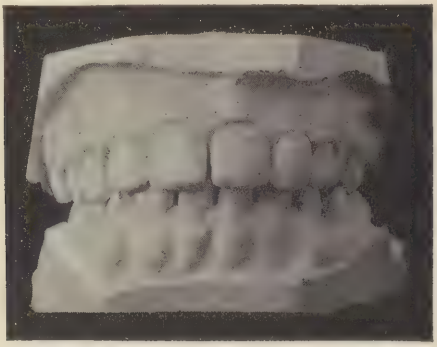


FIG. 144

Fig. 143 shows the case of a boy of seventeen years, who had been a sickly child, and had always had poor teeth. He was placed in my charge by a dentist from another city. In two sittings of two and one-half hours each, in the morning

and afternoon of the same day, his teeth were restored as shown in Fig. 144.

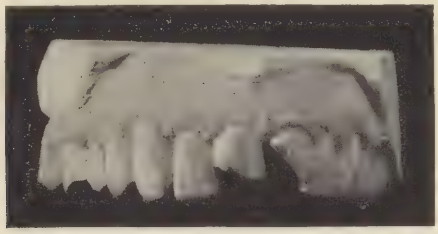


FIG. 145

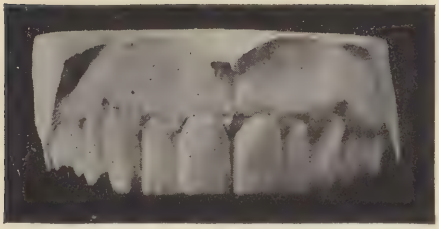


FIG. 146

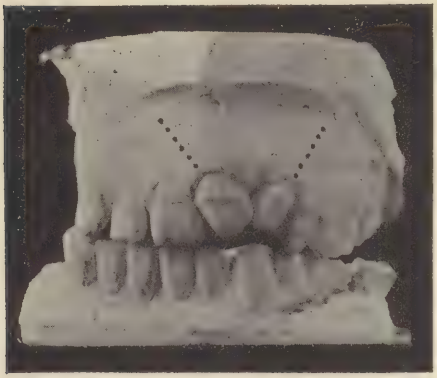


FIG. 147

Fig. 145 shows the case of a man who had been thrown from his horse. The crown and root of the left central was

FIG. 148

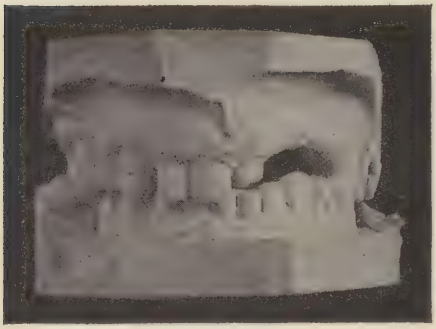


FIG. 149

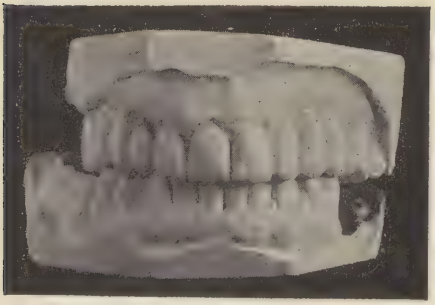


FIG. 150

fractured and the pulp of the right central killed by the shock. The restoration is shown in Fig. 146.

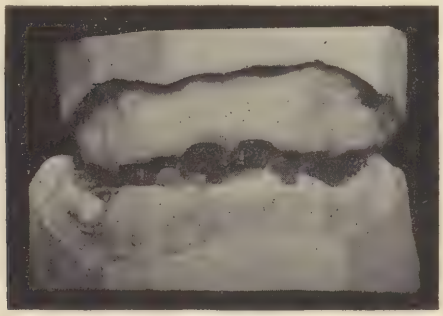


FIG. 151

Fig. 147 shows the space between occluding surfaces caused by non-eruption of the left lateral incisor and the angle formed by the left central and canine. This case was corrected by two jacket crowns, which produced a marked

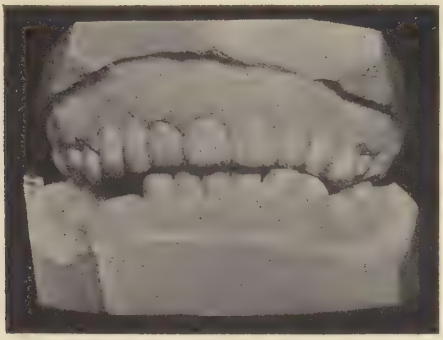


FIG. 152

improvement in speech and appearance (Fig. 148). The pulp of the central was devitalized, because the angle of

the tooth required extreme cutting. The dark patch shows a gum enamel inlay made to make the central more complete.

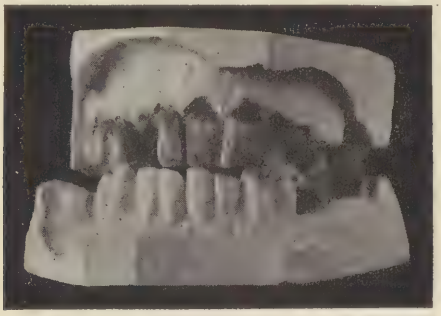


Fig. 153

Fig. 149 is a recent case selected to show the use of the jacket crown as a bridge abutment. This patient is fifty-six years of age and a tobacco-chewer, hence considerable con-

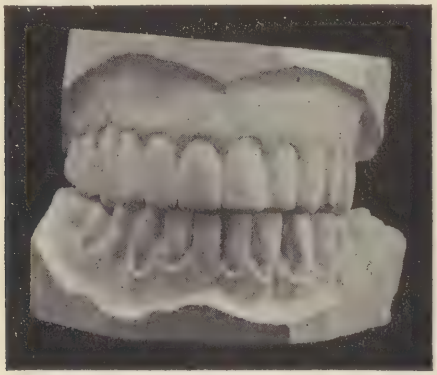


Fig. 154

fidence must be placed in the strength of this crown under such circumstances (Fig. 150).

Fig. 151 is the case of a girl of fifteen, the most extreme of its class. Every tooth was devoid of enamel and stained dark brown, with several teeth unerupted. The bite was raised by shell crowns on the molars, and sixteen other teeth were covered with jacket crowns. No devitalization was necessary, the only inconvenience and pain being caused by the preparation of the teeth at the gingival margins. The remaining spaces were left for the possible delayed eruption of teeth. This was the most extensive restoration I have made and a dental success, but the change in facial expression was much objected to by the child's mother (Fig. 152).

Fig. 153 is a recent case and represents the mouth of a man of thirty-six. This condition was caused by neglect through discouragement, for the patient had had much dental work done but failed to keep it in presentable condition. He is wearing partial upper and lower gold dentures to supply molars. Gum enamel was fused to the margins of the centrals to replace the receded gum. In order to make a strong clasp tooth on the left side I united the two bicuspids, which were loose and had an extreme forward angle, made a foundation covering both teeth, and then carved what could be called "twin teeth," thereby securing stability and natural appearance by correcting the angle and unsightly condition (Fig. 154).

Fig. 155 shows a case of tobacco-staining from smoking. This picture may appear to be darker than any natural teeth could possibly be, but they were like polished ebony and very disfiguring. The correction was made by jacket crowns and no pulps devitalized. This patient being a "gritter" of his teeth while asleep the incisal edge of porcelain was protected by an increased thickness of iridioplatinum.

Fig. 156 represents the mouth of a young dentist whose centrals had been broken by an accident when twelve years of age. The larger part of the breakage extended lingually and under the gum margin. The boy's father, a dentist, replaced the broken teeth by means of a pin and gold band, which was a clever repair, but conspicuous. Note that the left lateral is deformed and on the right is an extension bridge carried by a gold shell on the cuspid.

The correction, as in Fig. 157, was made by post and tube

crowns on the centrals. A jacket was placed on the lateral, the right cuspid covered in the same manner and the right

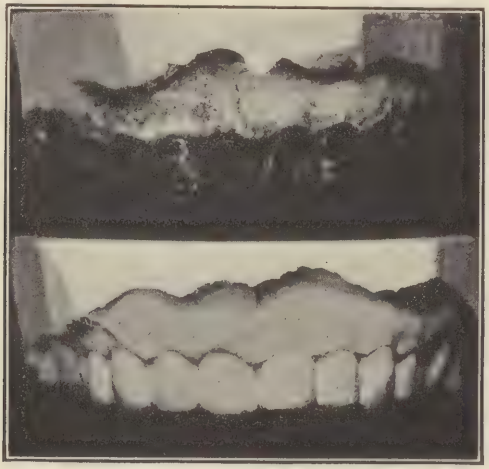


FIG. 155

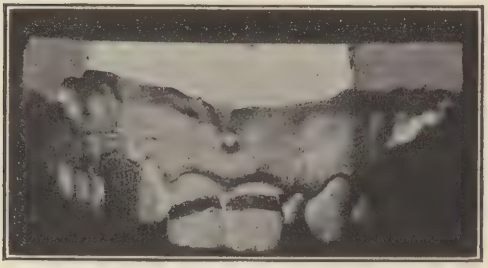


FIG. 156

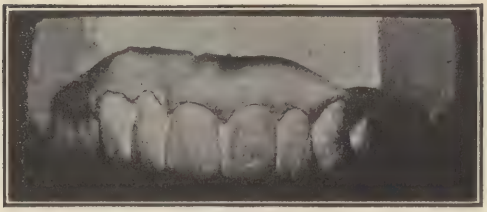


FIG. 157

lateral was restored by a soldered back tooth extension carried by the cuspid.

Fig. 158 shows a case of a girl, ten years of age. Broken central and fracture extending longitudinally. This serious condition was one in which the correction could not be delayed, although, it is preferable to operate when the child is older (mentioned in a previous chapter). A band was

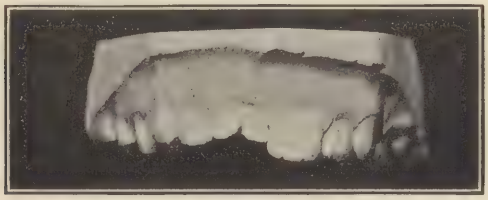


FIG. 158

placed tightly about the tooth and the nerve extirpated and the canal filled. Two small screw posts were tapped on each side of the fracture and bound together with platinum wire and amalgam packed over the broken end of the tooth and around the pins and wire. The band was then removed and the tooth prepared and covered with a jacket crown, making a very presentable substitute, as shown in Fig. 159.

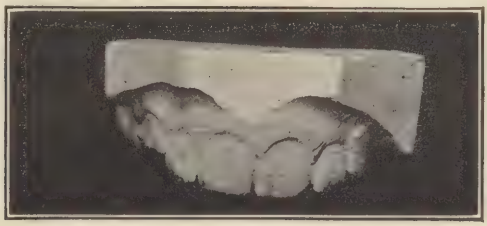


FIG. 159

THE OVERLAP CROWN.

This crown is probably a more recent form of the jacket or covering process applied particularly to the anterior teeth and possesses value from the fact that the lingual

portion of the natural tooth does not require preparation. It is not covered with porcelain or metal, giving it the advantage of reducing bulk and leaving the natural surface for contact. There is also no obstruction if at any time the root requires treatment.

The preparation consists of grinding the natural tooth sufficiently to allow for a porcelain veneer. The thickness of the veneer is governed by the shoulder at the neck or gingival border extending mesially, labially and distally. The mesial and distal portions are grooved to assist in retention. The form is shown in Fig. 160. The working base is platinum inlay foil $\frac{1}{1000}$ thickness, with sufficient excess to allow it to meet on the lingual surface and be held in position while burnishing. After the matrix is partially burnished it is withdrawn and the butting edges held with pliers and soldered with a small portion of pure gold. This procedure assures the form and is a means of easy manipulation, while the matrix is being placed and withdrawn several times during the operation. The foil is thoroughly burnished to place and a complete adaptation is made before applying the porcelain. This is the important and difficult part, and that being satisfactory the rest of the procedure is comparatively easy. A veneer is used as in other jacket crowns, or if desired the porcelain can be carved, but a thin veneer assures the desired shade. This is ground thin and placed in position on paste porcelain and using the pliers, the form is withdrawn, placed in the furnace, fused to a high biscuit and then applied to the tooth for readjustment. Burnish the edges under the gum and at other abutting parts, withdraw and fuse to a finish. The platinum is stripped from the crown in the same manner as in inlay work, using care not to break the porcelain edges. The finished crown will appear as in Fig. 160.

Etch the interior with hydrofluoric acid before cementing. It is generally an advantage to construct the foundation of jacket crowns on the natural tooth because accuracy of adaptation is a chief requisite for strength and durability. In this instance a deviation is permissible because the gum and adjoining teeth interfere somewhat with the adjustment

of the thin foil, therefore a model can be used for the forming of the matrix (Fig. 162). This model must be of some hard material, such as Mellotte's metal, cement, amalgam or Spence's metal, and is made according to directions as given

Fig. 160

for "Making Inlays by the Indirect Method" (Chapter II). Using a model allows the excess matrix foil to spread well beyond the margins, then after burnishing the excess is trimmed close to the working line and the burnished form is adjusted to the original tooth and again burnished, fitting the slight excess under the gum margin.

Fig. 161

Fig. 162

Using a working model allows the dismissal of the patient and the making of the matrix at some opportune time.

Making a pattern of tin-foil will give accuracy and save platinum waste.

ADDING PORCELAIN TO READY-MADE CROWNS.

A great majority of dentists are accustomed to the use of ready-made crowns, such as the Logan and Davis, and an immediate discontinuance of their use is not to be expected; but the art of making them more adaptable is one of the most valuable details in porcelain work, hence a few hints for guidance may be appropriate as a preface to what is generally considered the more ambitious operation of making an all-porcelain crown.

Ready-made crowns can sometimes be adapted very closely and with but little preparation; but to do this considerable time is taken in getting the shade, length and approximate size of the tooth, especially at the neck. These requirements are not always to be found combined even where a large number of crowns are available for selection. To one so situated that a varied stock is impossible, these difficulties are often insuperable, as evidenced by the number of misfitting and off-colored crowns so frequently seen. A crown may have correct shade and fair proportions but be too short; in that case the addition of porcelain of the right shade will be all that is required and probably save time and delay. The case may be one of such irregularity that adaptation to the neck is very difficult, whereas by the addition of porcelain at that point perfect adaptation is readily secured. Or the case may have a root adjoining a vacant space where absorption is of long standing, as in Fig. 163. Under such conditions it is recommended that porcelain be added to the neck of the crown on the distal surface. This is done in the following manner:

After the preparation of the root and canal, fit the crown approximately with particular attention to the bite; then burnish thin platinum foil, about No. 50, over the surface of the prepared root, getting the outline well defined, leaving only a small amount of margin beyond the outline. The next step is to push the crown in place as shown in Fig. 164. At this point let us save time if possible. One method is to cover the face of the platinum with wax before putting on the crown and then drawing it off with the platinum attached,

investing and soldering on the pin side. This, however, means additional time and risk of checking. It is easier and preferable to cover the surface of the platinum with stiff, sticky porcelain and force the crown to place, absorb excess of moisture with bibulous paper and gently withdraw, dry in front of the furnace and bake with strict attention to careful heating. After the first bake, trim the surface of the platinum closer to the neck and partially pull from the edge, so that when the crown is put in place the edges are sure of contact; add more body to take the place of shrinkage, then finish. One fusing may be sufficient. These same directions can apply to the banding of a root in connection with a Logan crown; but pin and cap would probably require soldering if the adaptation were good, as there would be too much resistance for anything but hard wax.

FIG. 163

FIG. 164

FIG. 165

FIG. 166

Using a Davis crown under the same circumstances requires a different technic, because of the fact that the pin and crown are separate. We will therefore start with the pin in position (Fig. 165). Twist a piece of platinum foil around the pin exposed, or, better, take another of the same dimensions, holding the root end with one hand and turning the foil about the exposed end; this gives a small tube. Then take a small square of the same metal, large enough to cover the end of the root, and punch a hold in its center; place the tube of platinum in position and push the square over it so that it fits accurately; then draw off together and solder with a little pure gold; burnish the square portion over the end of the root; this gives a little cap covering the whole (Fig. 165).

Pinch the ends of the tube together, cover the whole with a

mass of sticky porcelain and force the crown to place, and the whole combination can easily be removed. After baking, the metal next to the root is removed, leaving the tube in the crown intact, and in this manner getting a perfect adaptation to the root with the crown in a regular or irregular position, as the case may be (Fig. 166).

AN ALL-PORCELAIN CROWN WITH BANDED ROOT.

One of the simpler forms of an all-porcelain crown, and a kind that is much used—in fact, it is safe to say more used than any one other—is this crown, chiefly because of its simplicity, as all are taught to make the base required for this operation.

FIG. 167

FIG. 168

FIG. 169

I allude to that which is made in the same manner as a Richmond crown, but with porcelain for a backing instead of gold, and the base and post made of platinum soldered with pure gold. It has the advantage of being easily and quickly made, and is applicable to any part of the mouth with equal security. The shade can be made accurate and with no fear of change by addition of porcelain.

This crown has been described so frequently that general directions must be thoroughly known, but a few points gained by an extensive experience may be of some value. One of these is the soldering of the tooth pins to the crown pin or dowel. This is not always necessary, especially on the anterior teeth, for in those cases the back of the tooth will probably rest against the pin, as in Fig. 167. In such a case soldering can be avoided by filing a groove across the top of the crown pin on both sides and bending the tooth pins around it, thereby saving time, avoiding the chance of check-

ing and securing a better quality of porcelain through the absence of solder. With bicuspids and molars this cannot always be done without drawing the facing too far in; but even with these teeth, and where the facing pins are long enough, I have avoided soldering by placing a small wedge of platinum between the tooth and post, as shown in Fig. 168. The main value of soldering is to secure retention of position until the porcelain is added and fused. This is contrary to the general idea, but if the point is considered thoroughly it must be admitted that once the tooth is finished and the whole interior is a mass of solidly fused porcelain, no change is possible, nor is breakage more liable.

Another point worth noting is the unnecessary grinding of the facing to get an accurate adaptation to the platinum base; it is a waste of time, as an approximate fit is all that is needed, a little space giving a better opportunity for filling in with porcelain. It is advisable also to allow the facing to protrude slightly over the edge, as seen in Fig. 168, so that the added porcelain can extend quite to the edge of the band, thus preventing a dark line under the gum and allowing for the slight recession of gum which usually takes place after a time.

Several writers on this subject have recommended the soldering of a pin to the crown base for additional strength, particularly in bicuspids and molars (Fig. 169). This may be advantageous in some instances, but, as a rule, it is unnecessary, for a breakage at this point is a rarity. If, however, something is desirable for extra strength I consider the cup form of band an important addition to this class of crowns.

Use square wire for root pins, and when possible an old Logan crown pin; it is one of the best.

CROWNING A SPLIT ROOT.

The promiscuous use of crowns having excessively large pins has been the cause of much serious trouble through the splitting of the roots in which they are cemented. This generally leads eventually either to the mutilation of adjoin-

ing teeth to make abutments for some bridge arrangement or to the compulsory use of a plate, either expedient being a legitimate cause for concern to the patient. Using the jacket crown in some cases of that kind is practical, especially if the root is only slightly cracked and the damage has been discovered before the fissure has been forced open sufficiently for the gum to penetrate.

The mode of procedure is simple and without complications. Draw the fractured edges together by twisting a fine platinum wire around the end of the root with an odontometer, forcing the wire well under the gum (Fig. 170), after which the canal is enlarged and extended to the solid end, for in the majority of split roots the fracture does not divide equally but much as represented in Fig. 170, in the proportion of about one-third to two-thirds. If the fracture is central

Fig. 170

Fig. 171

Fig. 172

throughout, these directions cannot apply. The root is drilled, capped and a How screw post dipped in thin cement is gently turned to its place. While the cement is soft, pack amalgam about the projecting end of the screw and allow it to harden; the result is as shown in Fig. 171. The ends of the platinum wire are cut closely and bent against the side of the root, thereby lessening irritation to the gums or lips and the patient dismissed with the usual precautionary advice. At the next sitting the wire is cut, and as it gives the correct circumference of the root, it can be used as a measurement in making the crown, as already described; the result is shown in Fig. 172. This is an accurate description of work of this kind done by me in several instances. In each case the result has been sufficiently lasting to pay for the effort. In one case a second bicuspid was preserved in this manner in active

service for eight years, and would have had a longer life but that it had no support on the molar side, that tooth having been lost.

Frequently roots have been condemned because the canal has been enlarged to such an extent that an ordinary pin crown has no chance for permanent retention. This condition often results from a frequent loosening of the crown, the canal being enlarged at each resetting until it becomes useless, or is generally considered so. The insertion of a post and the addition of amalgam, making a foundation as shown by Fig. 174, is a method which can be used in almost every instance where such conditions exist. The same directions apply also to a root that has decayed considerably, leaving a thin edge at the gum line and having insufficient strength for any pin crown. Treated in this manner such roots will give satisfaction and often develop surprising strength and durability. I recall one case in which four incisor roots in one mouth were treated in this manner over thirteen years ago, and they are now strong and healthy where they were loose and decayed, because in giving them length for contact they became normal in condition. The patient is credited with having fine-looking teeth, and yet the roots had been considered beyond the pale of salvation and condemned to extraction.

CHAPTER IV.

THE PORCELAIN HOOD OR JACKET CROWN.

By J. Melville Thompson, D.D.S.

History.—In the latter part of 1902 Dr. C. H. Land, of Detroit, exhibited to a few of his friends an all-porcelain hood or jacket crown for vital teeth. One of those to whom this work was shown was Dr. E. Spaulding, who was so impressed with its possibilities that he immediately adopted the principle involved, and soon developed a high degree of skill in its use. Dr. Spaulding exhibited one of these crowns to a few of the men of Detroit who were enthusiastic in the use of porcelain, at a meeting of the Detroit Dental Society, early in 1903. In June of the same year he gave the first clinic ever given in this work at the annual meeting of the Michigan State Dental Society held at Petoskey. Later in the year Dr. Land and Dr. Spaulding gave a joint clinic at Rochester, where the work met with an enthusiastic reception and was started on its way to a prominent place among the good things in artistic dentistry.

In December of the same year Dr. Spaulding demonstrated the crown before a meeting in New York City. The author also exhibited one of these crowns to a group of friends while attending a meeting of the Institute of Dental Pedagogics held in Buffalo during the last week of December of the same year, and also enjoyed the distinction of making the only practical case of the jacket crown made at the Fourth International Dental Congress held at St. Louis in August, 1904. This clinic was reported in the proceedings of the meeting and also described in *The Items of Interest*, also in a French journal published in Paris, France. Dr. W. C. Herbert gave a very instructive table clinic at the same meeting. Probably no other valuable addition to the possibilities of

dental art was ever so eagerly welcomed by a few, so admired and neglected by the profession in general, as the jacket crown. Even after fifteen years of successful service by these crowns there are men of great prominence crying out against them, claiming that they are impractical, as teeth must "breathe" to remain in a normal condition. In spite of this, however, hundreds of teeth are "holding their breath," so to speak, and only poor judgment upon the part of the man making the crown has caused any of them to have other than the sweetest kind of breath.

Clinical Considerations.—Indications for the use of the porcelain jacket are many and varied. This crown was originally designed for *vital* teeth, but the beautiful results obtained by the jacket method have led many to use it in a general way. A separate chapter would be necessary to describe its use upon the pulpless teeth.

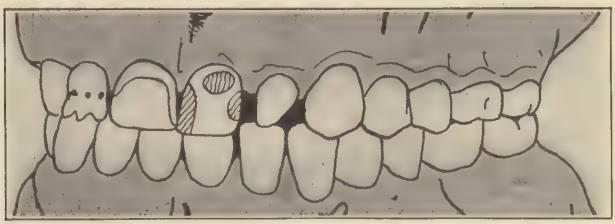


FIG. 173

Malformed incisors and cuspids, teeth devoid of enamel from erosion, overfilled incisors and cuspids, in fact any tooth may be successfully prepared and crowned, but the best of judgment is called for in these cases.

Preparation.—*Preliminary Considerations.*—Unless years of experience in avoiding the dental pulp governs the work of preparation an examination by means of an *x*-ray is very necessary. This is doubly essential if an anesthetic is to be used as an aid in determining the size and exact location of the pulp.

In the early days of this work, aside from a general anesthetic and cataphoresis, there was nothing to offer the patient to avoid pain. A little later pressure anesthesia was intro-

duced and then followed the ether spray, and now we have gas analgesia and conduction anesthesia. Any of these agents in the hands of a careful operator are permissible, but much harm can be done by hurrying an operation, the danger of overheating a tooth being always present.

Study of Models.—In different cases it is extremely desirable to have an articulated set of models for study purposes. This applies to cases involving a number of teeth and enables one to determine the amount of cutting necessary, also allowing one to study the amount of stress the work will have to stand. In constructing porcelain jackets it is always well to

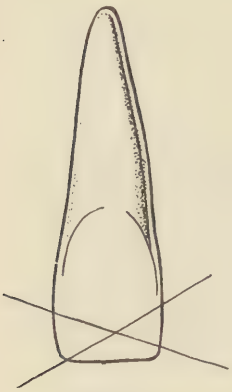


FIG. 174

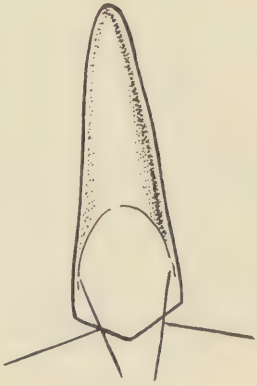


FIG. 175

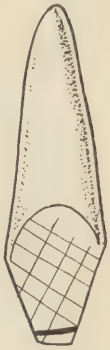


FIG. 176

study the characteristics of the adjoining teeth and note the amount of wear that has been brought about by the habits of the patient.

Methods of Preparation.—*Instruments Used.*—The first step in preparing any tooth is to remove all of the enamel. For example let us use a central incisor. The first step in preparing an incisor is to remove the incisal edge with a thin clean disk; this may be accomplished in two cuts (Fig. 174). The lateral walls are then removed with the same disk to a point nearly as high as the shoulder, which will be made later in the operation (Fig. 175). With a true running knife-edge stone cuts are made across the labial surface (Fig. 176), which are in

turn recrossed by similar cuts. It is highly essential that this cutting should extend through the enamel, after which the little diamond-shaped pieces of enamel may be removed with a chisel or with sharp cross-cut burs. At this time two ferrules should be fitted and laid aside for the impression which will be taken later. Ferrules of any standard make which come in assorted sizes are very desirable for use in this part of the work.

Authorities differ as to the advisability of removing all the enamel, but it makes little difference who is right, as in the majority of cases the judgment of the operator must be

FIG. 177

FIG. 178

the deciding factor. The arguments brought forward by the advocates of the entire removal of enamel are that the enamel remaining becomes disintegrated and falls out, leaving a ragged surface for the gum to rest upon. After the bulk of the enamel has been removed the shoulder is established by the use of end-cutting, safe-sided burs, and this is facilitated greatly by using a number 18-gauge soft-copper wire drawn about the tooth and used as a retractor to hold the gum back while performing this delicate part of the work. When this is completed and all surfaces found to be planed true, there will be no pulling of the impression by any little elevations (Fig. 177). Teeth with deep festoons

like Fig. 177 must be carefully considered, for if all the enamel were removed from such a tooth much unsupported porcelain would be placed on the lingual surface and sooner or later would be broken off (Fig. 178), leaving an undesirable roughness which would not occur if enough of the enamel on this surface had been left and the joint allowed to show above the gum margin. The shorter we can make our line of joint the less opportunity for decay exists and a stronger piece of work is obtained (Fig. 178).

In the early days of the jacket crown facings were used by the majority of operators, and it was desirable to grind the facing to fit the tooth before the matrix was made. This enabled the operator to determine just how much of the tooth was to be sacrificed in constructing the crown. Many

Fig. 179

difficulties had to be overcome in the selection of facings, owing to the change of color that necessarily took place after the underlying color had been ground out and the change which took place in the fusing of other porcelains upon the backs of the facings to complete the work. This led such men as Lauderdale, Tinker and Snyder to building their own crowns, and this practice has been generally taken up by all the best porcelain workers in the country. It is just as easy to build a crown with two or three different colors in it as it is to make an inlay of two or three different colors, and when one has become familiar with the work he hesitates to do it any other way.

Methods of Forming the Matrix.—There are three distinct methods of forming a matrix, the swaged, the cone and the solder joint, and the one the joint of which is made with a

tinner's overlap. The soldered cone, Fig. 182, was first brought out by Dr. Spaulding, and it is indicated where the operator desires to work by the direct method.

Technic in Forming the Cone.—Having taken the measurement before the tooth is cut down, we cut the wire in the odontometer and lay it upon the platinum and mark the point, cutting the platinum a trifle longer than the wire. This allows for a small lap joint. The measurement which

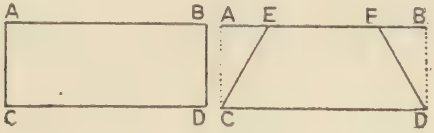


FIG. 180

will eventually become the apex of the cone which will be formed from the platinum should be about one-third shorter, thus giving a gradual taper as in Fig. 180.

The soldering of the platinum cone is a very simple matter if the few following points are closely adhered to: The horn of a small anvil has about the right taper to form this cone upon; the platinum is wrapped around the horn of the anvil and the edges overlapped a very little; these are gently rubbed

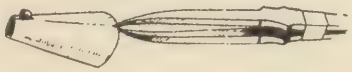


FIG. 181

together with either a piece of soft rubber or soft wood and then slipped toward the smaller taper of the anvil and grasped in locked pliers (Fig. 181). If this has been carefully done there will be no springing of the metal. A piece of gold laid inside the cone right over the joint and passed through a Bunsen burner will solder very beautifully the whole length of the lap. Metal burnishers should be avoided as they have a tendency to harden the platinum and thus make it more

difficult to handle. If there is any tendency for the platinum to spring out of the position into which it has been placed it should be re-annealed. It is essential that only enough gold to solder this joint be used, because an excess flows over the surface of the platinum and will eventually burn out while firing porcelain upon it, and it is also a prolific cause of bubbles in the porcelain.

As mentioned elsewhere this cone is well adapted for the direct method. The first step in its use is to trim it to the gum line, and if found to be too large it is gradually cut away until it slips easily but snugly over the shoulder at the neck of the tooth. A little experience will soon teach one the proper allowance to make for the drawing in of the platinum when burnished to this shoulder, for unless

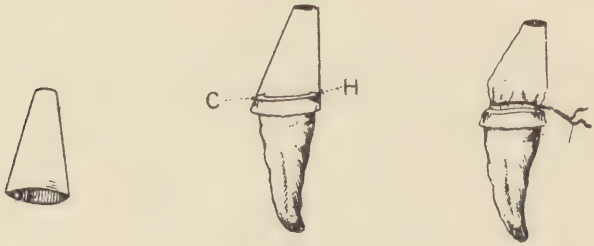


FIG. 182

care is exercised it will be drawn away from the opposite side and will make trouble when trying to complete the work. If the soldered joint has been placed mesially or distally it sometimes becomes a hindrance, as it does not bend readily in adapting the matrix to the tooth. It should therefore always be placed upon the labial surface of the tooth. It is then held in position on the lingual surface while the labial surface is burnished in position and enveloping the tooth about half its circumference. A piece of soft modeling compound is then pressed down upon the finished portion and the lingual surface completed. This forms two projecting portions of platinum (*I* and *J*, Fig. 183) which are pinched together with flat-nosed pliers and turned down against the surfaces already burnished (*K*, Fig. 183). The end is then

trimmed and burnished down smooth (Fig. 183). This makes a very neat matrix and one that is easily handled in working directly upon the tooth.

After the burnishing has been completed we are now ready for the adaptation of the facing, which has already been ground (Fig. 179). This is placed in position (Fig. 184) and united

FIG. 183

to the platinum on the lingual surface with a little ball of wax, such as is used in dental depots to retain the teeth upon the trays. It is then removed, the matrix being held in position by the wax. In order to remove this wax and retain the facing in its proper position, Taggart's inlay wax is melted over the joint (at *O*) on the labial surface sufficient to hold

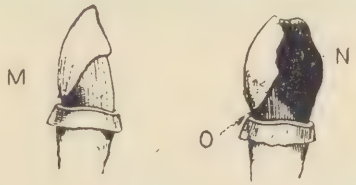


FIG. 184

it firmly in position while the other wax is removed. The porcelain powder is now added to the back of the facing, after having thoroughly washed all saliva and blood, if any, from the work and wiped the facing with alcohol. This porcelain powder should be mixed with a saturated solution of cornstarch water, as this seems to form a better union during the

drying-out process, thus holding the facing in its proper relation when placed in the furnace. A bed of finely powdered silica placed upon the slab which is to carry the work keeps the crown in its position and does not in any way become part of the porcelain. Before placing the crown in the furnace it should be allowed to stand before the door of the oven while the Taggart wax melts out and then burned out as the work is slowly passed into the oven. This porcelain is given a biscuit bake which will be sufficient to unite the platinum and porcelain so that it may be replaced upon the tooth for reburnishing. After this burnishing has been completed

FIG. 185

it is removed and the porcelain added to complete the work. In using the direct method it is absolutely necessary to keep the margin of the matrix free from porcelain until the final fusing is made.

Indirect Method.—For the indirect method the burnished matrix with the tinner's lap joint is the most desirable. Before cutting the platinum it is advisable to partly burnish a tin matrix and in this way secure a pattern for cutting the platinum, thereby saving much waste. When this pattern has been secured and platinum cut ready for use, place the metal at a point that will bring the joint where the greatest amount of porcelain may be laid over it (Fig. 185).

It is then held against the model by the first finger of the left hand and teased into position by the use of a basswood stick and the shoulder clearly defined in the platinum, gradually bringing the ends of the material together (Fig. 186). They are then pinched together with dressing pliers with long beaks and trimmed to conform to the shape of the model, leaving enough material for the overlap joint (Fig. 187). It is then removed and a little apron cut in the top which is to be burnished over the end of the model. When this has been done it is replaced and before closing the joint this apron is brought over the end of the model in such a way

FIG. 186

FIG. 187

that it will be inside the matrix when completed (Fig. 188). The ends are then brought together and bent over, forming a lap joint. The completed matrix is then removed and the surplus material trimmed away from the cervical border (Fig. 189).

We are now ready for the building of the porcelain. Having selected the colors which will enter into the tooth, we add the first layer over the entire matrix, leaving the borders free and clean. This is then placed in the oven and given a biscuit bake. More material is then added (after having reburnished the matrix) and the shoulder completed, thus

forming a cap which will not change form during subsequent bakings. The overlying color of the porcelain is now spatulated into place and the crown built up according to the ideals of the operator.

There is much controversy as to whether a spatulated crown is as strong as one that is packed in a mold, but as far as one can determine from years of experience and observation there is very little difference in their durability.

During the winter of 1916 and 1917, Dr. O. W. White, of Detroit, was instrumental in forming what is known as the Clinic Club of the First District Dental Society. This club

FIG. 188

FIG. 189

has a membership of about 80, divided into sections covering all phases of dentistry. The porcelain crown section of which Dr. A. L. LeGro is chairman adopted the principle of the jacket crown as the one above all others, and developed a technic which has made it possible to form a crown by the indirect method, which needs no grinding or finishing of any kind when ready to set. An outline of the technic is as follows:

We will take as an example a devitalized molar, the roots of which have been previously treated and filled and verified by the *x*-ray. Before the walls of the tooth are cut down too

far a measurement is taken and two bands are made and fitted over the tooth. These are laid aside and the tooth ground down even with the gum line, with the edges a little below the free margin of the gum. The pulp chamber is then prepared to receive a cast or inlaid core, which extends into the root canals, which are prepared parallel to receive short posts. This core may be cast of gold or pure silver.

Pure silver is more acceptable than any of the metals like Weston's or Acolite. The indirect or the direct method may be used in forming this core. It is sometimes desirable to use the direct method, as it saves one office call for the patient.

After this is ready and cemented into place the bands are fitted to the root and a modeling compound impression taken and a cement model made at once. Upon this cement model two tin-foil matrices are made and two cement caps made upon them. One of these is placed upon the tooth and acts as a guide for the seating of the model in the impression which is now about to be taken. The other is to be worn by the patient during the time in which the crown is being completed.

Modeling compound is used as an impression material in preference to plaster; the consistency of the compound is such that it enables us to force the cement cap into its exact relations and at the same time secure the articulating surfaces of the adjoining teeth in an accurate and stable material. Experience has shown that plaster works in between the cap and the root and upsets the fine adjustments of the model later. The modeling compound should be thoroughly warmed and placed in a tray and the part next to the tray chilled in cold water, and before taking the impression the upper surface should be heated over an alcohol or gas flame, and in this smooth, shiny condition a little cake of cocoa butter rubbed over the surface to avoid its sticking to the teeth. After the impression has been thoroughly chilled and removed the amalgam model which has been prepared is then placed in the cement cap and waxed into position by enough material to make a little gate in the plaster model.

The adjoining teeth are then packed with cement into which little staples are placed, which form a union with the plaster, which is now poured into the impression. This

produces a model which is accurate in every way, and then the wax is cut away from the amalgam model so that it may be removed and worked upon, the same as taking the individual tooth right in your hand.

The impression for the opposing teeth is also taken in modeling compound and after being thoroughly chilled the ends are closed with other modeling compound, so as to make a receptacle into which Spence metal may be poured. Those of you who are familiar with Spence metal know that this material melts at a little below the boiling-point of water, and if properly handled may be poured into a compound impression and a very sharp model secured. Before pouring it is necessary, however, to oil the impression with paraffin oil. If a plaster impression is taken it must be flooded with oil, which is displaced as the Spence metal is poured into the impression. The object in using such a model is that the black material is very hard and marks the high spots on the crown better than carbon paper.

The method of securing the articulation, as described by Dr. LeGro, consists of two tin-foil cups made by burnishing No. 40 tin-foil over the models and reinforcing the sides with sticky wax. These are then placed in the mouth and the patient is asked to close the teeth in their proper relation, and these two cups are joined together by more sticky wax. These are removed and the models placed in them and mounted on Kerr's anatomical articulator. Some prefer the wax bite and others prefer making models of both the upper and lower jaws in order to do away with any possible tilting of the models in their narrow wax bite. After this is done we are ready to start work upon the crown, and in this connection I would say that the technic up to this point is just as good for gold as it is for porcelain.

In view of the fact that porcelain shrinks about one-fifth of its bulk, a strip of pink base plate wax is wrapped about the model, just even with the margins of the root and this acts in a twofold manner. It holds the matrix in place and increases the circumferences of the root enough to overcome the shrinkage in the block of porcelain, which we are about to prepare. A piece of clean, white paper is now

wrapped about the model and a loop of Cutter's waxed floss passed around it and fastened by simply twisting the ends down tightly.

Coloring.—Having determined the color to be produced, we mix the darker or underlying body of porcelain and pack it into this paper tube, having it higher at the center than at the margins. Then the next color is mixed and placed over it. This mass is then vibrated until every particle of moisture that can be brought to the surface is removed. The element of hardness obtained by this method is most surprising, as a block of body is secured which almost has the consistency of a crayon of chalk. In fact it has been made so hard that a sentence has been written on the blackboard with it. This block of porcelain is now carved to the shape required for the case at hand, care being taken not to remove any from the portion forming the mesial and distal surfaces. The wax is carefully removed from the model and all porcelain carved and brushed away from the margins of the matrix. This is then removed from the model and placed in the furnace and given a high biscuit bake. After this has been done it is placed upon the model and the model placed in its accurate relations in the plaster model, and any grinding or shaping that is necessary is done at this time. If it is necessary to place a little more of the porcelain to complete contact points or cusps it may be done at this time and the crown completed, excepting the margins. After this has been completed the margins are reburnished and the crown finished with porcelain that fuses at a slightly lower temperature.

Color schemes in anterior crowns are the most difficult ones with which we strive. To imitate in a satisfactory manner an organic substance with a resisting mineral substance and to produce a substitute which will in all lights have a natural appearance requires a good eye for color and a knowledge of how the different shades will harmonize when fused together. It is almost impossible to take a stock tooth and make a baked crown and have it as satisfactory as the hand-carved or spatulated crown. We have known for years that an inlay made of several colors laid one over the other more closely resembles the tooth into which it is inserted than one made

at one or two bakes without regard to such a principle. This is equally true of the tooth as a whole, as we very often find cases where, in order to secure a harmonious blending of the colors found in the adjoining teeth, we must make one side different from the other. Experience is a teacher which

Fig. 190

conducts its business upon a pay-as-you-enter, or to be more accurate, as-you-leave basis, and it is owing to this fact that many become discouraged and do not continue doing porcelain work. There are so many little reasons why we fail

Fig. 191

that a little thought on a few general principles should make mistakes more rare occurrences. Take one little matter of technic for example. Many times after we have secured a block of body and have it nearly ready for the oven we may chip off a little corner, which at that stage of the work would

seem very important. The novice generally tries to replace it at once, but the old head who has had sad results from trying this will fuse or biscuit the case as it is and add the fresh material later. His reason for this is that adding moist porcelain to that which is nearly dry upsets the consistency of the mass and causes checking and weakened results.

In the early days much stress was laid upon the necessity of keeping the margin of the shoulder clear of porcelain until the final baking, but it is the practice with some to let the porcelain run over the shoulder, and just before the crown is completed this porcelain is ground to a fine joint, the same as we would grind a gold inlay in an amalgam model. After this has been done the crown is placed in the furnace and the glaze restored. This method seems to be the most desirable way of obtaining perfect adaptation.

An ideal case of jacket-crown restoration is shown in Figs. 190 and 191.

CHAPTER V.

PORCELAIN BRIDGES.

As very much has been written and published on this phase of the application of porcelain it is not probable that much of value can be added to this subject.

The application of porcelain to restoration of natural teeth was preceded by many years by the full porcelain denture or continuous gum plate and many of the makers of that most beautiful prosthetic appliance were also the first to devise and use porcelain bridges. It was a natural diversion of their artistic skill and mechanical genius because it was an outlet toward variety and what can be properly termed the unknown. We owe much to Drs. Land, Parmly, Brown, Jenkins, Goslee, Swartz, Nyman and others who have applied such skill to this difficult section of dentistry that we are enabled in a great variety of ways to practice this part of porcelain art with a sense of security otherwise impossible without much experimentation.

There has been much discussion of and no doubt there remains opposition and antipathy to porcelain bridges, but there are many valuable acquisitions to our profession that are only accepted by a small minority. Opposition is natural if the object in discussion is something requiring special skill or trained experience. It is also asserted that what may be termed ordinary bridge-work will encompass the field of usual application and thereby fulfil all desired requirements with few exceptions, thus eliminating the special training necessary in a few exceptional cases. This is no doubt true to some extent, but knowledge by which certain difficult corrections can be made is a very gratifying possession.

Porcelain bridges are primarily esthetic and hygienic, with great possibilities of strength. While porcelain is a vitreous and friable substance it has inherent strength which may be utilized in proportion to its judicious application.

This class of work is particularly adapted to spaces where the absorption is extensive and has reached a permanent condition and also where the spaces are not too extended between the abutment teeth. In such cases the strength is ensured by quantity of material and opportunity afforded for a superstructure that must be unyielding. The ideal form under these conditions is the removable denture, and yet it is possible to construct a stationary section quite acceptable from a hygienic standpoint.

As the cosmetic value is one of the principal recommendations it is necessary that this asset should predominate, therefore an attachment not in accordance with this principle should not be considered unless applied to a posterior position. Anterior abutments should be all porcelain or a shell of platinum covered with porcelain, but not a shell porcelain, because they have no attaching strength.

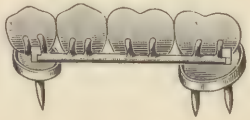


FIG. 192

The basis of all porcelain bridges should be made of platinum and iridioplatinum united with platinum solder. The most usual abutments are banded crowns, as shown in Fig. 192, united by an iridioplatinum bar soldered to the base of the abutments and the facing pins soldered to this bar as in Fig. 192; however, in some instances the abutments can be platinum shells using platinum solder to reinforce the cusps. The shell crown is quite applicable to a molar, and any abutment anterior to that can be a platinum base porcelain jacket; in fact, it is the crown I recommend for this purpose, because it is not only very strong but has the possibility of avoiding pulp devitalization. The value of porcelain bridges when applied to the anterior teeth, particularly when gum tissue is lacking, is without question, because in many instances gum enamel can be used most naturally. The abutments should be jacket crowns when possible, which

will allow a greater amount of the natural foundation to be retained. When the bases of the crowns have been made an impression is taken and the operation is finished on the model after the bar has been soldered to the crown frames and tried in the mouth to note accuracy.

If the space to be bridged is between the two cuspids or an intermediate space before the facings are soldered to the bar, platinum foil is burnished to the model along the alveolar ridge as a base for the finished enamel, which is to be substituted for the gum tissue lost through absorption (Fig. 193). The central and lateral fronts are now soldered to the bar, or if desired the whole bridge may be carved in one block, but the use of flat back teeth will save much time and secure the desired shade.

FIG. 193

The packing of the porcelain body must be carefully done so that shrinkage will be equalized and not distort the platinum foil, which must be covered also for it is the base-work of the gum enamel. The cuspid veneers are also placed into position so that one fusing will combine the whole mass.

Great care must be used in drying thoroughly and heating gradually, and when fused to a hard biscuit the cooling must have equal consideration. It is recommended that the bridge be tried in the mouth and changes caused by shrinkage or heat distortion noted and corrected at that time. All crevices and shrinkage checks are filled and the desired form made and again fused without the gum enamel. The enamel is slightly lower fusing and generally requires a separate baking, but with experience it is possible to finish a bridge with gum enamel attachment in two fusings. Before placing the bridge in position the platinum is stripped from the porcelain, thereby giving the artificial gum a more natural color.

A bridge of the extent just described is not for an amateur

to undertake and should not be attempted until confidence is gained by smaller work, such as supplying a lateral or a central as shown in Fig. 194, which represents a case that was used for many years. For a long period I have reduced

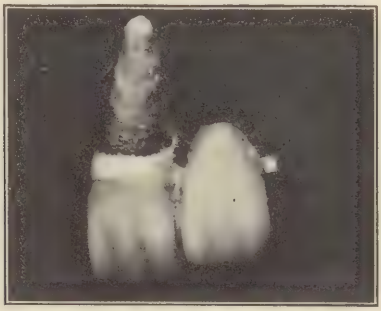


Fig. 194

the use of all porcelain bridges and have obtained practically the same results by a combination of gold-backed teeth soldered to the jacket abutment. The application can be made to any part of the mouth where gum enamel restoration

Fig. 195

is not necessary and the strength is sufficient for quite extensive spaces providing the abutments are rigid. Fig. 195 represents a small piece that had hard usage for more than ten years and was lost by neglect of the patient. Fig. 196

shows a case corrected in this simple manner. The centrals were devitalized and trimmed to suit a jacket crown and laterals added by soldering. A spur from the laterals rests on each cuspid for support. Fig. 197 represents the corrected case.

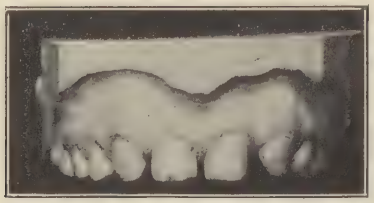


FIG. 196

These crowns being shells there is no possible chance of reducing the value of the foundation in case of breakage, and the repairing is a much simpler operation than is the repairing of any other crown. This statement applies particularly to the platinum-base jacket crown.

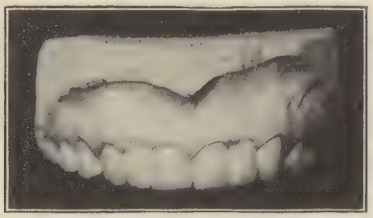


FIG. 197

PRACTICAL CASES.

Fig. 198 shows the case of a young lady with a contracted arch and irregular teeth. She wore a plate with two small canines to fill the spaces. She had for two years undergone orthodontic treatment, but with little success. Her speech was affected by the plate, which was an "insult added to injury," because of the additional space it occupied. The condition was corrected by two small extension bridges, using jacket crowns on the right and left laterals as abutments (Fig. 199).

Fig. 200 represents an extreme condition of abrasion, which was corrected largely by the use of the jacket crown. The lower anterior bridge was supported by these crown

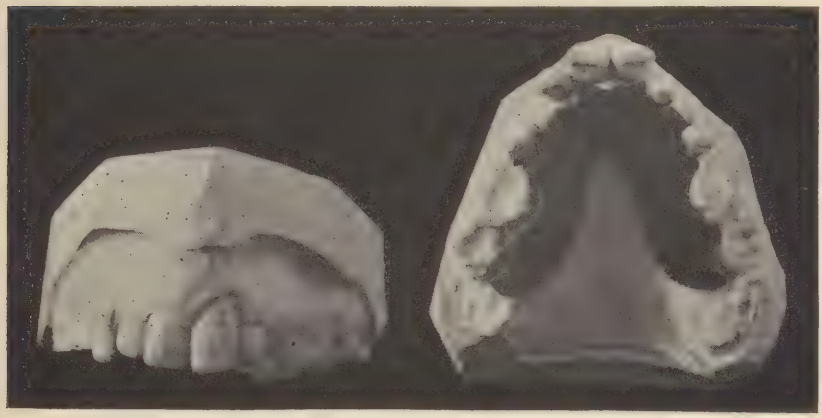


Fig. 198

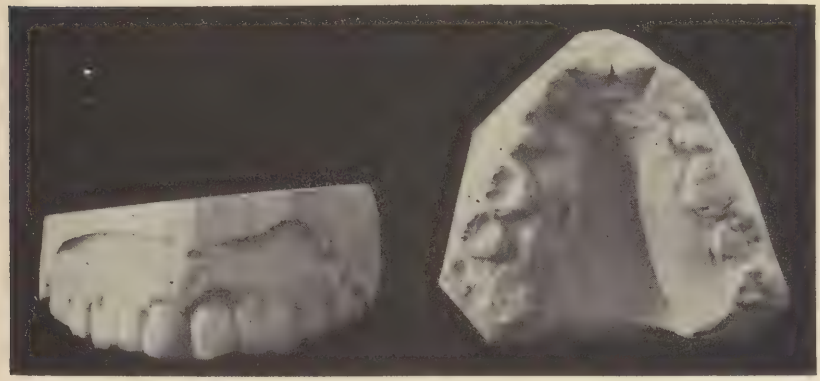


Fig. 199

abutments and stood the strain for ten years, after the facings of the soldered teeth had been broken away (Fig. 201).

ABUTMENTS.

The ideal porcelain bridge is one that is so constructed that there cannot be criticism from the hygienic standpoint. This has been overcome in many ways of constructing all

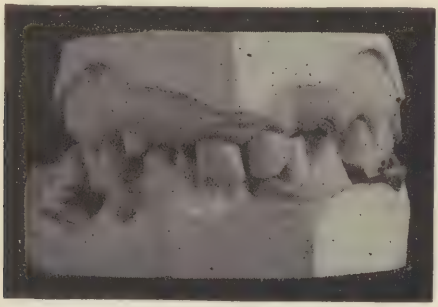


FIG. 200

gold removal sections, but the application to porcelain is a much more difficult matter because of the necessity of using platinum for a base on account of the great heat that must be used to make true porcelain. This fact debars many of the

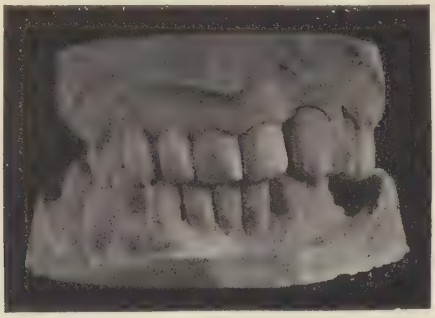


FIG. 201

ingenious attachments made of clasp metal, which is necessary for secure adjustment during use, therefore a description of a removal saddle bridge devised by the writer may be of interest.

Fig. 202 shows the abutments covered with gold clasp metal and cemented permanently. The mesial and distal surfaces marked *A* are cut so that portion may be sprung open to compress the approximating surfaces of the abutment crown. This is made in the jacket form and the construction is of the type shown by Fig. 114, p. 89, with the exception that iridio-platinum is used entirely, the gauge of which should be 30.

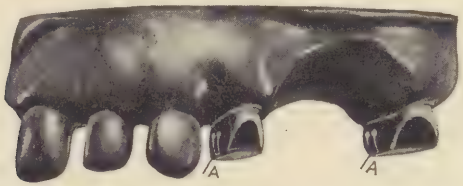


Fig. 202

The saddle is platinum plate, gauge 30 or 32, and swaged to fit the space accurately, and the bridge is made as already described on a previous page. Fig. 203 shows the palatine section and *B* the metal surface of the abutment crowns. Only the buccal surface is covered with porcelain. Fig. 204 represents the finished bridge ready for adjustment. An operation of this class is quite practical in every respect and

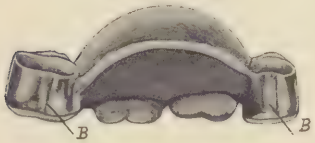


Fig. 203

Fig. 204

has the advantages of cleanliness and rigidity. The inner abutment springs will ensure the security of the bridge for a long period, but the patient should be instructed to return when a change is required.

Before the inner crowns are cemented the surface under the springs should be covered with gold, platinum or tin-foil, to ensure against a possible leakage.

CHAPTER VI.

COLORS IN OIL—THEIR PRACTICAL USE IN PORCELAIN WORK.

By Robert Brewster.

It is not within the province of this chapter to discuss the subject of color—in relation to porcelain—in all its varied aspects, but rather to deal with its practical application to our every-day needs.

Porcelain in dental prosthesis at the hands of skilful manipulators already rivals in usefulness and excels in beauty the more generally used and time-honored metal. But with a fuller comprehension of the valuable properties of porcelain and of its possibilities has come its more general adoption.

It has been said that its possibilities are limited only by the ability of the operator: in other and familiar words, that it is "the man behind the gun." Although this is true in many respects, as is evidenced by ocular demonstration both in inlay-work and bridge-work, yet the artistic sense cannot be fully developed without the requisite materials and a knowledge of their use.

We are but on the threshold of artistic dentistry, artistic in the sense that utility—in the restoration of lost organs or lost tissue—is being governed more and more by esthetic considerations. The work of Dr. Rudolph Beck in restoring facial expression (in connection with artificial dentures) by means of paraffin is an illustration in one direction; the adoption of porcelain for restoring lost tooth structure is another, and the employment of oil colors as an aid in obtaining more natural effects in all classes of prosthetic work is a still further evidence of this view.

The "foundation body" and "enamel body," with its large variety of natural coloring (twenty-seven shades), has

done much toward rendering porcelain work in its higher requirements possible. But with the addition of properly prepared high-fusing colors in oil the "porcelain artist" takes a step forward, and we then see effects which astonish us in their close imitation of nature.

In treating this subject the coloring will be divided under two heads: "overlaying," which means the application of color to a practically finished surface, and "underlaying," by which is understood the coloring of a surface afterward to be covered with the "enamel body."

STAINING TEETH.

Overlaying.—Under this term is included darkening the shade of laterals and cuspids in a set of six anterior teeth to agree with conditions found in nature; darkening or changing the color of plate facings, whether for use in porcelain work or gold bridge-work; and staining porcelain crowns at the cervical and upon the occlusal to correspond with similar markings on the adjoining natural teeth; this includes the representation of tobacco-stained teeth, Hutchinson teeth, etc.

When a crown is indicated in an arch composed of teeth with defective enamel, presenting grooves and pits, the usual plan is to take a facing and cut the required markings into its surface with a diamond drill; but however well this may be done the effect is not very natural. A better plan is to make the crown entirely of body, using the "foundation body" for about two-thirds the bulk and *well fusing it to secure a sound attachment*, then covering, building up and contouring with "enamel body." While this body is in the soft state—that is, before baking—the finest lines may be produced with carving tool and small brush, and there will be an entire absence of that mechanical appearance in the pits and grooves inevitable when drills are used upon a hard substance.

Darkening the laterals and cuspids in a set of six teeth demands quite a little skill, owing to the necessity for retaining the same *tone* of coloring throughout the set; for although the

laterals may be three shades darker than the centrals, and the cuspids three shades darker than the laterals, the difference must be one of intensity of color only and not of tint. A few experiments in color mixing are necessary to familiarize one's self with the processes involved.

As a practical illustration of the process we will take a set of fourteen teeth, say shade 5 on the Justi shade guide. As purchased the set presents a uniform color from centrals to molars and is known as a yellow shade. The *tone* of color pervading the upper half of this set will be reproduced by mixing equal parts of yellow and brown, and the method of employing them is as follows: Place on one of the pallets an equal quantity of each color, sufficient in all to paint twelve teeth on their labial and buccal surfaces (the exact quantity of color can only be determined by experience), then drop from the pipette some of the prepared oil on to the pallet and with the spatula incorporate thoroughly. It is important that the color and oil be worked thoroughly together until quite smooth and the colors perfectly mixed. The consistence of the color when mixed should be about that of cold glycerin or the fluid of a good oxyphosphate cement.

The color being now in the right condition it must be applied to the tooth with a patting motion, not brushed on as one would apply color to canvas. In thus applying the color an evenness of surface is obtained and an extra thickness left at the neck, becoming thinner toward the center of tooth. To obtain the blended effect found in a well-shaded tooth the color must be thinner as the cutting edge is approached. To secure this effect dip the brush into the jar of oil of turpentine, and with this oiled brush draw a little of the already mixed color to one side of the pallet. The color thus thinned down will allow of its being applied in the thinnest possible film over the remainder of the tooth, even to the extreme cutting edge if desired. Sufficient color should be applied to the two laterals to make them perceptibly darker than the centrals, and to the cuspids to make them still darker; the color on the cuspids should be brought nearer to their cutting edges. The bicuspids and the molars should be darkened to agree with the cuspids; the occlusal surfaces may be

painted in the sulci with a brownish stain and the ground cusps (if any) with a color which will restore their original appearance and smooth surface.

The most difficult teeth to change are those with very little color in them, such, for instance, as No. 8 on the Justi guide, or No. 35, the corresponding color on the White guide. The formula for the upper third of this tooth would be brown, two parts; yellow, one and one-half parts; white, one part. These colors must be thoroughly incorporated, as previously directed.

A simple method of arriving at these proportions is to make heaps of each color on the pallet. After a little experience this method becomes sufficiently practical for all purposes, but if preferred each color may be weighed to a previously prepared table, and doubtless this plan will be adopted by many at first to be afterward discarded as their artistic abilities develop.

The formula for darkening the upper part of a tooth the color of No. 48 on the White guide would be brown, three parts; yellow, one part; red, one part; black, a trace. This will give the *tone* of color desired; the intensity is governed by the thickness of the layer of color applied.

On entering this work it is a good plan to make up mixtures and paint on pieces of porcelain or old teeth, recording the proportions, and after baking compare with teeth on the shade guides, remembering always that in comparing a sample with the neck of a tooth—to ascertain whether the correct *tone* of color has been reached—that only the same amount of each must be exposed to view, otherwise the eye is liable to be deceived by the shading in the baked tooth.

The illustrations given are sufficient to indicate the possibilities in the way of "overlaying." We will now consider the method of "*underlaying*" and its field of usefulness.

PRODUCING COLORS IN FUSED TEETH.

Underlaying.—It is not uncommon when selecting facings for porcelain work to find one exactly right in size and shape and color of neck, but needing some change toward the cutting edge.

It may be that the blue at the cutting edge is either too dark or too light. In the former case reduce the thickness of the lower third of the tooth by grinding at the back, then paint on some white color (mixed with oil as previously described) and bake; then apply the "enamel body" of the desired tint in finishing the crown. If, on the other hand, the blue is too light, reduce the thickness of the tooth a little by grinding and paint on blue color in a good, thick layer; for if the point has been darkened too much the excess of the blue may be ground off before the "enamel body" is added.

The same method applies to yellow, brown or gray pointed teeth. To darken a gray point, black should be used. In all cases the single color will be sufficient, except, perhaps, in the case of a very pronounced brown, when the addition of a little red to the brown color will be beneficial.

In matching an adjoining natural tooth it is sometimes necessary to show in the facing a line of blue just above the cutting edge. If the facing is thick, grind a slight groove or depression on the back and paint in the blue color. The depression will fill up with the "enamel body" in constructing the crown. If brown spots are desired and a facing must be used, these are better painted on the face of the tooth with a very small quantity of color of the proper tint. To reproduce in a facing the opaque white spots associated with defective enamel the labial surface must be ground into and white color painted into the depression and baked, the surface afterward levelled with enamel body of the proper tint to correspond with that particular portion of the tooth.

PRODUCING PROPER COLORS IN INLAYS.

We now come to the employment of these oil colors in inlay work. Inlays are the severest test for porcelain. No more difficult task presents itself to the operator than the accurate matching of the mesial or distal surface of an incisor involving its cutting edge, especially so if the tooth is of a pearly white, translucent character. In the majority of such cases the "enamel body" will give beautiful results, but there are cases where our best efforts seem to fall short of perfection, and it is with just such teeth as mentioned that

our greatest difficulties arise and where oil colors prove of much assistance.

We will take as an illustration a tooth of the character just referred to: The procedure would be to line the matrix with white "foundation body" and bake; then contour out as needed and bake again; then paint it over with white color and bake; afterward apply the "enamel body," either the "A," "B" or "XX," to the fulness required. The "foundation body" alone, covered with either of the numbers mentioned, will make an exceedingly light colored inlay, but a still whiter effect is obtained by using the white oil color under the coating of "enamel body."

The satisfaction derived from making an accurate match in such teeth is well worth the trouble involved in reaching such a degree of manipulative excellence.

When brown or white spots are desired in any portion of an inlay they should be painted immediately under the last layer of "enamel body." The color must always be baked where painted before the covering of body is applied, and in no case should porcelain be ground with a carborundum wheel or any of its imitations; good corundum is the only thing to use, excepting, of course, the diamond.

COLORING GUM BODY.

One other feature of oil coloring still remains to be mentioned, viz., the pink gum effect, which is better attained by painting than by the other method of laying on a one-colored body mixed with water. In the latter case bulk is increased and artistic effects of light and shade are difficult if not impossible of accomplishment. On the other hand, with oil colors in two shades of pink, various tints of gum may be more accurately matched, and scope is given for the display of artistic work in shading to break up that monotony of color which is noticeable even in pink gum enamel. Cases will be found in practice where the employment of a small quantity of pink color is oftentimes very desirable, especially so when no addition is made to the bulk of the case.

From what has been shown it is evident that with materials as now prepared those desiring to achieve excellence in this department of dentistry have much to assist them.

CHAPTER VII.

LOW-FUSING PORCELAIN INLAYS.

By N. S. Jenkins, D.D.S., and W. W. Bruck, D.D.S.

By low-fusing porcelain is understood any ceramic body fusing below the melting-point of gold.

A matrix for fusing such a body is best prepared from rolled gold-foil. Number 30 or number 40 may be used. The thickness of these foils is as follows:

No. 30 .00038332 inches: .009736 millimeters.

No. 40 .00051111 inches: .012980 millimeters.

The technic of preparing a cavity for a porcelain inlay is practically identical whatever body may be used.

THE DIRECT AND INDIRECT METHOD.

We agree with Dr. Capon in personally preferring an inlay made by the direct process. If the preparation of the cavity has been completed and left with clearly defined borders and all the enamel edges, as well as the interior of the cavity, have been polished with Arkansas stones, or in any way which gives everywhere a smooth surface, it is comparatively easy to obtain a perfect matrix by the direct method.

This method has also the advantage of making it practicable in many cases to preserve much more of the healthy portion of the tooth than when the indirect method is employed; as, for instance, in proximal and crown cavities in a bicuspid or molar.

The value of the gold inlay has been impaired, not only by an excessive zeal for "extension for prevention," but also through the necessity of sacrificing much sound tooth substance where the indirect method of making gold inlays has been exclusively adopted. There are innumerable instances of patients who have had their teeth mutilated and have

suffered unnecessary distress and permanent disfigurement through indiscriminate use of the gold inlay, where a porcelain inlay, made after the direct process, would have been preferable.

Low-fusing porcelain is peculiarly adapted to complicated cavities involving grinding surfaces. It is only necessary to have the cavity walls very slightly divergent from parallel, and of sufficient depth to secure an inlay which is perfectly resistant to the strain of mastication. If, after years of use, the inlay is found, owing to the wear of the crown, standing somewhat above the surface, it can be polished to a perfect line and level. This is made possible owing to the thin gold matrix and the fusing of the body in an open oven, where the trained eye can observe the process and thus make more certain of obtaining a denser body than one fused in a closed furnace where the heat is indicated by a pyrometer.

Such an inlay furnishes greater security from secondary decay than is the case with one of gold and also is incomparably more comfortable to the patient, by reason of its being a poor conductor of heat. When a porcelain inlay has been cemented into a large cavity in a vital tooth, the pulp immediately becomes as secure from shock, through sudden change of temperature, as if that tooth had never needed treatment.

There seems also to be no question of the more certain obliteration of the dreaded "black line" through the use of the gold matrix and low-fusing porcelain. Theoretically the assumption is a logical conclusion. Gold-foil may be used much thinner than platinum foil. It is softer and can be far more perfectly adapted to a cavity without break or tear. The edges, and indeed the whole matrix, can be finally burnished by a light touch with a glass burnisher, so as to secure an adaptation to the cavity which leaves nothing to be desired. A porcelain inlay cannot be forcibly driven into place like a gold inlay, and therefore a slight space must intervene between the porcelain and the cavity, but it is obvious that this space should be as thin as possible at the edges, where the cement should be almost non-existent, although elsewhere it may have considerable bulk if desired.

GLASS BURNISHERS.

For about twelve years glass burnishers have been used in Europe. They are easily made. A glass rod, such as is kept by any dealer in chemical supplies, of about the diameter and length of a lead-pencil, is well adapted to the purpose. The rod, at a point about an inch from the end, should be exposed to the heat of a Bunsen burner and slowly revolved until the glass softens and bends. The shorter end, which still remains hard, may then be grasped by a pair of plyers, when the rod can be drawn out to the desired tenuity and broken off. The thin point may then be again heated, when it will roll up to a suitable size. The tapering shank below the ball can readily be bent to any desired angle through renewed heating.

The best evidence of the value of these instruments was furnished by the experience of the instructors of the Post-Graduate School established by the Dental Institute of the University of Berlin. In 1913 we asked Mamlok, who was the head of the porcelain inlay department, what was the result of teaching the use of glass burnishers? In reply he sent out notices to a considerable number of patients to appear at a certain hour. They promptly presented themselves and Mamlok showed us many porcelain inlays in all possible positions in the mouth, every one of which had been fused in a gold matrix. We could not find in these not too well kept mouths a single dark line about any of these inlays, many of which had been made three years previously. They had all been made by men and women dentists coming from various European countries to take advantage of the Post-Graduate Course, some of whom had for the first time attempted porcelain inlay work. This work has maintained its vogue in Europe to a greater extent than in America, for the reason that Europeans are very averse to being disfigured by a display of gold or any other startling evidence of dental repair. European dentists, therefore, have vied with each other in learning how to conceal their art and have attained a high standard of efficiency in porcelain work in

consequence. They have been greatly aided by the early use of the gold matrix and the necessity of imbedding it.[1]

A European dentist in full practice has an assistant, usually a woman, who takes the matrix, or the impression of the cavity, and prepares the inlay. In the former case a simple inlay may be so quickly finished that the restoration can often be completed in one sitting. When the matrix, either of gold or platinum, has been properly imbedded, the work is much simplified. The overlapping edges are covered with a layer of the investment material and the packing and fusing of the inlay are greatly facilitated through the matrix being thus secure from distortion or other injury during the entire process. Under these conditions there exists no necessity for returning the matrix to the cavity for fresh burnishing, for if the matrix has been originally exact the finished inlay will as exactly fit the cavity.

Low-fusing porcelain has the advantage of a lower degree of translucency than is the case with the high-fusing bodies, by reason of which it conforms more nearly to the natural tooth in the reflection and refraction of light. Another advantage is, that this material can be fused in an open furnace, where the process can be observed without strain upon the eyesight, and thus not only contour, but also color, can be more exactly assured.

The fundamental difference between a gold and a porcelain inlay is, that the former is the product of an admirable mechanical system, which could be standardized and which was conceived and is practised for reasons of utility. The latter is, however, the product of an exquisite art, which combines beauty with superior utility.

The preparation of cavities for the reception of the low-fusing inlay is practically the same as that for the high-fusing inlay and as that phase of the subject has been fully covered in Chapter II we shall not repeat it here but proceed with the description of the various steps in the making of the low-fusing porcelain inlay that involve variations from the process of making high-fusing porcelain inlays.

[1] Jenkins: The Porcelain Inlay in Europe, Dental Cosmos, 1915, p. 269.

MAKING THE MATRIX.

It cannot be too often emphasized that taking the impression is at the same time the most important and the most difficult part of the procedure. Not until by continued practice one has acquired great skill in taking impressions of all sorts is he qualified to use this method with success. This or that difficulty which one meets at the beginning he must learn with patience to surmount, since it is only by the study of failures that we learn to avoid them.

Unless the impression be perfect it is impossible that the filling should serve in the least degree to preserve the tooth.

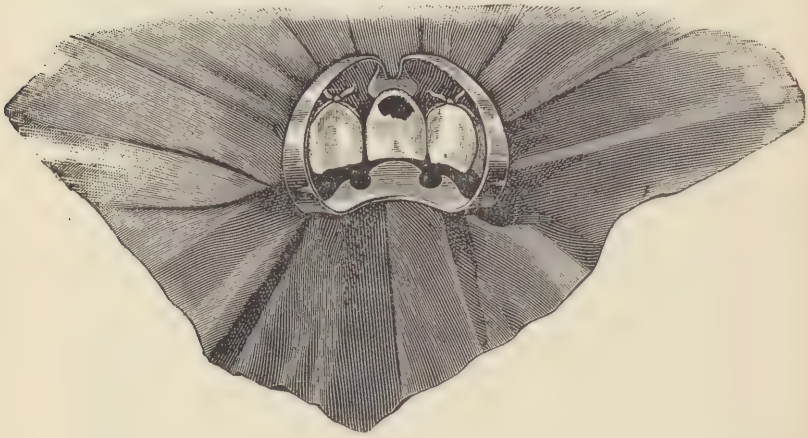


FIG. 205

Rubber Dam.—Whenever the situation of the cavity renders it possible it is advisable in taking an impression to adjust the rubber dam. For example, in labial cavities in the front teeth, where the Ivory clamp holds the dam well away from the field of operation. The two neighboring teeth must also be included in the isolation, in order that the rubber may not interfere with the gold-foil of the impression and perhaps alter its position (Fig. 205).

Should it be impossible to use the rubber dam and clamp

—if, for instance, the cavity extends beneath the gum, there remain two methods of procedure by means of which we may keep the region perfectly dry.

Dental Napkins.—The napkins, of linen, about 20 cm. square, should be folded triangularly. For cavities in the front teeth the point of the triangle will be placed under the lip (Fig. 206); in the case of cavities farther back in the mouth the napkin should be pressed against the cheek, and, as shown in Fig. 206, will be held in place against the alveolar process by the lip or cheek and the help of a finger. The broader portion of the napkin may be pushed into the mouth to form for a time an effectual protection against saliva.

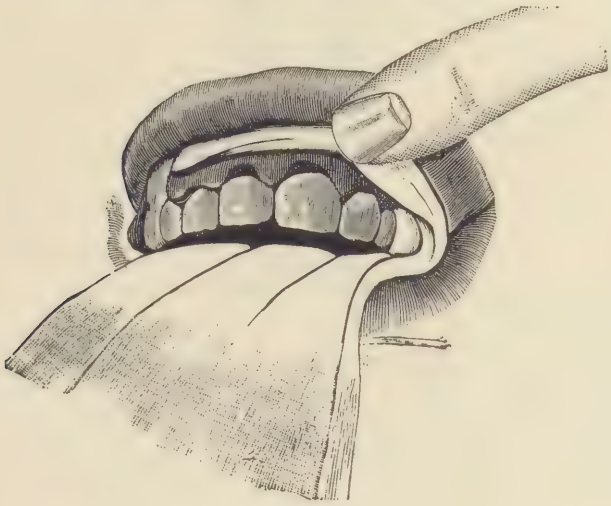


Fig. 206

The Harvard Clamp.—For excluding saliva the Harvard clamp (Fig. 207) is useful in many cases, applying it to one of the adjoining teeth. By means of the two arms which carry absorbent cotton rolls the field of operation can be kept free from saliva for a considerable time. This clamp is made for bicuspids and molars.

Taking the Impression.—After the tooth and neighboring parts have been dried, the tooth should be painted over with

some fatty substance such as vaseline, in order to make the withdrawal of the gold-foil impression easier.

Various aids have been presented to render the taking of impressions easier. It has been proposed to take first an impression of the cavity with Stents's Composition or wax, prepare a model, and then press the gold-foil into the mold. There has been a special swaging apparatus made for this purpose, but none of these aids are suited to give such an impression as we can obtain by the following method, which insures a representation of the cavity that is in all respects accurate:

Fig. 207

The gold-foil Nos. 30 and 40, used for impressions, may be kept on hand cut to various sizes, thus avoiding loss of time in this time-consuming work. The foil most to be recommended for this purpose is that of Williams or White. Williams's is somewhat tougher and does not tear so easily. Beware of using foil to which particles of Paris red used for polishing still cling. Fillings melted in such foil often take on a reddish tinge, especially at the edges, which may destroy the success of the filling.

For smaller cavities the thinner foil; for larger, the thicker is recommended. Various materials may be used for pressing the foil against the walls of the cavity, for example, cotton, soft erasing rubber, unvulcanized caoutchouc, soft chamois leather and spunk; for the most part spunk, cut to various

sizes, and sometimes small round pieces of chamois leather cut out with a punch, is preferable.

Place the already partly molded piece of foil in the cavity with the pliers and hold it steady upon the deepest part with a piece of spunk.

To beginners we especially recommend that in taking difficult impressions they make sure by the removal of the first piece of spunk that the gold is so placed that the edges will not be drawn into the cavity by the pieces subsequently introduced. This will surely happen if the foil has been cut too small or if it be not properly laid in the cavity. *During the whole time of taking the impression one holds in place with a blunt instrument, held in the left hand* (Fig. 208), *the pieces of spunk already placed in the cavity,* taking constant care that the foil does not lie pressed upon the edges of the cavity, which would certainly result in its being torn. For putting in the pieces one may use any pliers not too pointed. Those made for this purpose by Dr. Keyes (seen in Fig. 209), with points, that form a small ball when the instrument is closed and which prevent piercing the gold-foil are excellent for packing the spunk.

Continue to fill the cavity with spunk without exerting much pressure near the edges. When the cavity extends far under the gum and especially in approximal cavities, it is well to cut the gold-foil in the shape shown in Fig. 210, bending the upper edge *a* and laying a piece of soft chamois leather in the bent edge and placing them together between the teeth. This will prevent the gold-foil from being drawn into the cavity. Now take away the chamois skin and being sure that the gold-foil is in the right position, proceed to fill with spunk as described above. When the cavity is full the next step is to press the overlapping gold-foil upon the edges of the cavity. On this point it should be remarked that *it is of great importance for the melting to retain as much as possible of the foil in order to have during the melting a good idea of the situation of the cavity in the tooth.* However, there must not be retained so broad a margin of foil as to interfere with the removal of the impression from the cavity.

We now begin the removal of the spunk. With a pair of

FIG. 208

FIG. 209

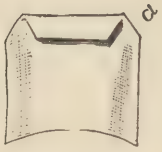


FIG. 210

sharp pliers we take out one piece after another, those remaining in the cavity being still held firmly with an instrument. If there is any point where the gold-foil does not lie close to the tooth, which may sometimes occur near the cervical edge, we must go over this portion either with the ball pliers or with the ball burnisher (Figs. 208 and 209), holding the foil meanwhile with a blunt instrument at some other part of the cavity. If it happens, especially in approximal cavities, that the foil is too large at the cervical edge, or that in the case of front teeth it extends too far over the palatal wall, so that it would be difficult to remove the impression without bending it, we cut away the superfluous part with a lancet or excavator, taking care to keep the impression in place by holding it with a blunt instrument.

If one has even the slighest suspicion that the gold-foil has altered its position in any respect, it is well to press it down again with a rather large piece of spunk to make sure that it lies closely against all parts of the cavity.

Removal of the Impression.—Before removing the impression examine carefully with the lens to make sure that the foil is lying closely upon all the edges of the cavity.

To loosen the foil a White excavator No. 97 (Fig. 211) is very helpful. In labial cavities the point is placed at the deepest point of the impression, when a light lifting movement is usually enough to remove it. In approximal cavities in the front teeth (Fig. 211) the point of the excavator is placed at the point marked *a* and an attempt made to draw out the impression by a downward motion, as indicated by the arrow; should the foil not loosen at the first attempt, continue by carefully inserting the instrument between tooth and foil, beginning at the point *b,* until the loosened condition permits withdrawal without difficulty. In approximal cavities of molars and bicuspids the impression is loosened both on the buccal and palatal sides. The removal of the foil is very difficult only in cases where the cavity has not been properly prepared; with patience we soon learn what to avoid in order to effect the removal easily and without bending the foil anywhere.

If rents in the gold-foil are present after removal from the

cavity, they will not affect the result *if they do not reach too near the edges.* However, it is well to aim at removing the impression uninjured, since rents in the foil, wherever situated, make bending more possible and require more careful attention during the fusing process.

Choice of Color.—The color assortment of Dr. Jenkins, selected from many hundred shades actually tested by him, should suffice for all cases, but if any other shade be desired, it can be obtained by mixing the powders furnished.

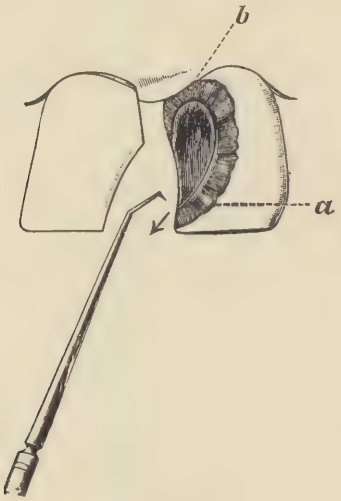


FIG. 211

In regard to obtaining good results in color it is desirable to remove the color patterns from the color fans and replace them by patterns made by oneself, giving each sample a fourfold fusing. The influence of the varying heat of different furnaces upon the color of the material differs so much that this precaution is much to be recommended.

In selecting colors, take for all labial cavities that which comes nearer to matching the tooth; for all approximal cavities choose a somewhat lighter shade. After matching the color *while the tooth is wet,* if the filling is not to be inserted

at the same sitting, fill the cavity with gutta-percha, first removing the vaseline or olive oil with carbolized alcohol.

In making contour fillings it is advisable to have the desired form constantly before the eyes. Therefore either take an impression of the cavity in Stent's compound, make from it a model in fine plaster, or model the contour of the tooth with gutta-percha, harden with cold water and remove. While fusing the filling, keep this model before the eyes to show how to build up the powder in order to perfect the contour.

Taking Impression (Dr. Sachs's Method).—At the meeting of the Central Union, held in 1901, Dr. Sachs described a process of obtaining a good impression of teeth having defects of contour which should be mentioned. Dr. Sachs remarked that the difficulty in the case of such teeth was not so much in getting good impressions as in building out the porcelain—usually for missing corners—to the proper shape. Even when one is skilful the tooth may not receive the proper slant, and it is difficult to give the corner a perfectly natural look if the work is guided only by the judgment of the eye. It is therefore desirable to secure beforehand a means of producing accurately the desired form. Warming a piece of Stent's compound the size of a walnut, it is pressed from the palatal side upon the tooth, the cavity and defective part allowed to cool, and then cut away from the Stent compound until only so much is left as represents the portion of the tooth that is to be replaced by porcelain. Then an impression is taken with gold-foil, the Stent compound model painted over with vaseline and pressed with the foil into the cavity so that the gold-foil outside the cavity lies closely against the Stent compound. The Stent compound is then removed, leaving the gold-foil in place, which is easily done, as the vaseline prevents adhesion. We now fill the hollow in the foil with wax in order to prevent bending the gold-foil on removal, invest in a mixture of plaster and asbestos, wash out the wax, and, putting porcelain powder in its place, proceed with the melting.

INVESTMENT OF THE MATRIX AND THE FUSING PROCESS.

We shall now speak of the apparatus used in the preparation of porcelain fillings. Since cleanliness during the fusing process is a chief requisite, it is advisable to have a special table reserved for porcelain work, which should be covered with sheet tin or iron and upon which all the necessary instruments and apparatus may be always ready for use. The bottles which hold the powder must be kept closed against dust; the spatula and brushes used for putting the mixed powder into the impression must always be carefully cleaned before using. It is desirable to have the furnace upon a stand just high enough to bring the opening of the furnace on a level with the eyes. There should also be a hermetically closed vessel containing asbestos powder mixed with alcohol; a bottle of alcohol having a drop tube; a number of plates upon which to mix the powders; pliers, spatula and brush; several footless wineglasses for covering the remnants of powder after the fusing; a pair of colored glasses to shield the eyes from the glow of the furnace, and the box of powders.

Investing the Matrix.—Dr. Jenkins has constructed a small platinum cup with a long handle (Fig. 212) for the imbedding of the impression, which one fills with the asbestos mixture, placing the impression in it with the pliers.

One must take care in imbedding the impression that the under side next to the asbestos be everywhere supported by the paste, which may be usually brought about by gently tapping the cup on the table: but in many cases, especially in complicated approximal filings, we now draw some of the paste from the edge of the cup with a spatula (Fig. 213), pushing it under the impression until sure that all hollow places are filled. There is another small but very important aid for the final success of the filling. In most cases sufficient gold-foil has been retained to show clearly the shape of the tooth and the surrounding parts. The superfluous gold-foil having been pressed closely against the tooth, pictures the situation of the cavity. We should imbed the matrix in such a manner that, as far as possible, we may have the cavity

before the eye in the fusing cup in the same relative position that it occupies in the tooth; we shall thus in most cases avoid putting in too much powder. Fig. 214 shows the prepared

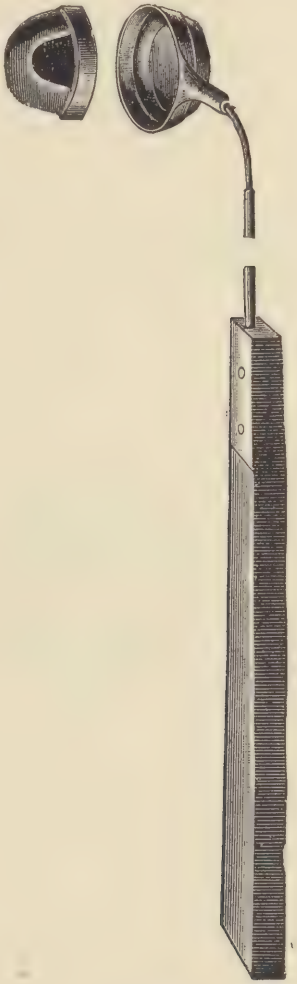


Fig. 212

cavity. In Fig. 215 the foil lies over the edges in such a way that it may be easily removed and will give an almost perfect representation of the tooth. In Fig. 216 the position of the cavity and the shape of the tooth can easily be recognized from the imbedded gold.

FIG. 213

FIG. 214

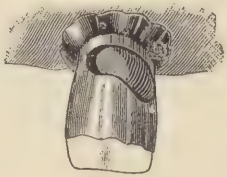


FIG. 215

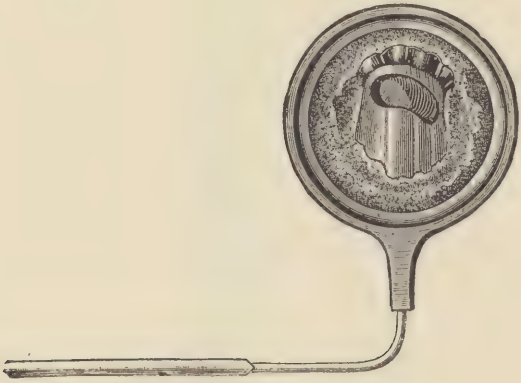


FIG. 216

When the impression is properly placed in the asbestos, ignite the alcohol contained in the asbestos paste and let it burn away completely. It will often happen that some of the paste has flowed into the impression, perhaps through a rent

at the bottom, and dried on by the burning out of the alcohol. It can best be removed by a brush wet with alcohol.

Filling the Matrix.—Place the probable quantity of porcelain powder required for the filling upon the agate plate furnished with the Jenkins apparatus and mix with absolute alcohol to a thin paste of cream-like consistency.

In mixing the porcelain powder with alcohol take great care that it be kept free from dust, threads or other impurities, since the smallest particles of dust may affect unfavorably the color of the filling. After moistening the foil with a drop of alcohol, fill the impression to the edge with the porcelain paste, which may be done with the spatula recommended by Dr. Jenkins, or with a very small, finely pointed camel's-hair brush. If the alcohol evaporates before the impression is filled, moisten the paste again.

The important point in filling the impression is that the paste should fill it perfectly everywhere, so that there are no hollow places beneath to cause bubbles in the fusing. We make sure of this by letting alcohol drop into the impression from the drop tube held in the left hand, while with a brush in the right hand we gently manipulate the paste until it is thoroughly distributed to every part (Fig. 217). We should also be careful *not to put too much paste at a time into the impression.* The asbestos, as well as the porcelain powder, should now be dried by burning out the alcohol before the fusing process begins.

Furnaces.—For this process Dr. Jenkins has constructed two similar pieces of apparatus, one for gas and the other for alcohol, this latter for the use of those who have not at command either gas or electricity. With the introduction of the alcohol furnace the last obstacle has been removed which in some localities prevented the introduction of the Jenkins method. Besides these two, the Mitchell electric furnace (Fig. 218) can be advantageously used for fusing the fillings.

The Jenkins gas furnace (Fig. 219) consists of an asbestos lined muffle, with an adjustable support, open in front and with an opening in the floor through which the flame enters. This is fastened to a base to which are also fixed the pipes for air and gas and the regulating device for the latter. To the

stand are fixed an arm for supporting the handle of the fusing cup and a shield of colored glass for the protection of

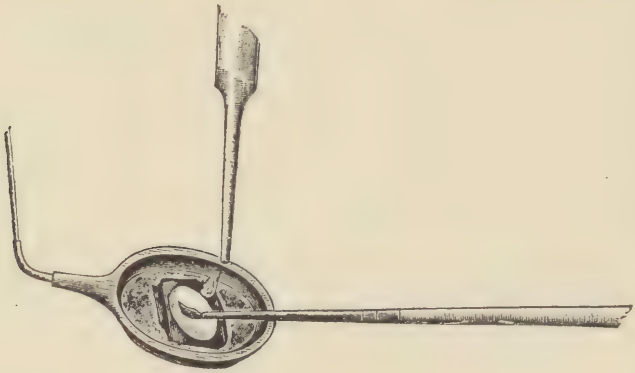


Fig. 217

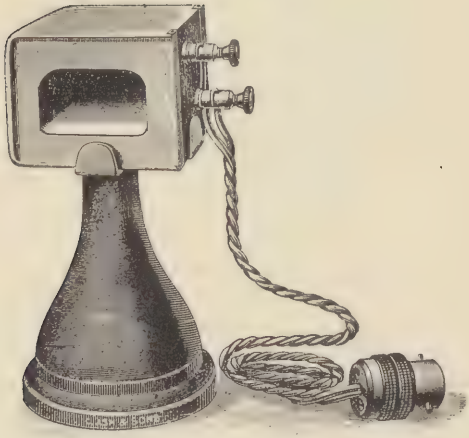


Fig. 218

the eyes. There belongs also to the apparatus a standing bellows connected with the blow-pipe.

The alcohol-gas furnace (Fig. 220) varies but little from the one just described, the principal difference being that the gas necessary for use in fusing must first be made in the small retort at the right of the apparatus.

The process is thus described by Dr. Jenkins: "The alcohol holder after removal of the screw *a* is filled with absolute alcohol and the screw replaced. The valve *b* is only a safety valve and the alcohol is on no account to be poured through it. The lamp *d* is filled with ordinary alcohol through the opening *c*, behind the holder, which is covered with a cap.

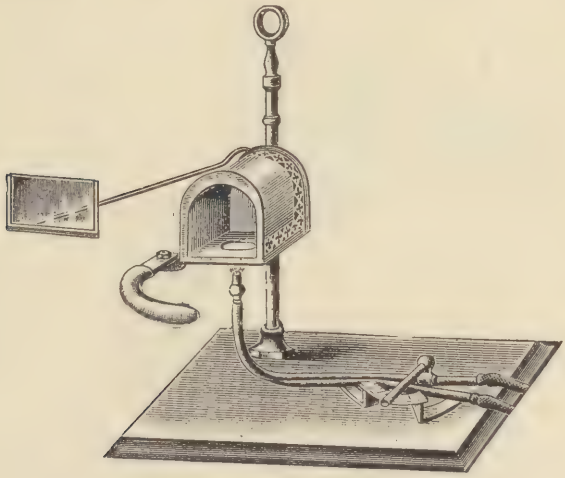


Fig. 219

Then the lamp *d* is lighted and the flame regulated by screwing the wick up or down. In a few minutes the absolute alcohol in the holder above the lamp will be sufficiently heated and the gas will find its way through the burner *e*. The products of condensation are carried into the receptacle *g*. As soon as the first drops fall into it, we can light the burner *e*. The contents of *g* can be used for replenishing the lamp. The standing foot bellows is connected with the tube *f* and a flame obtained that can only be blown out by a violent

use of the bellows. This flame can be regulated as desired by regulation of the lamp *d*."

In using either of these furnaces for fusing fillings, one covers the fusing cup with a nickel cap which has an opening through which the melting process can be closely watched (Fig. 212). We note here that the melting requires a longer time in the alcohol gas furnace than in the other.

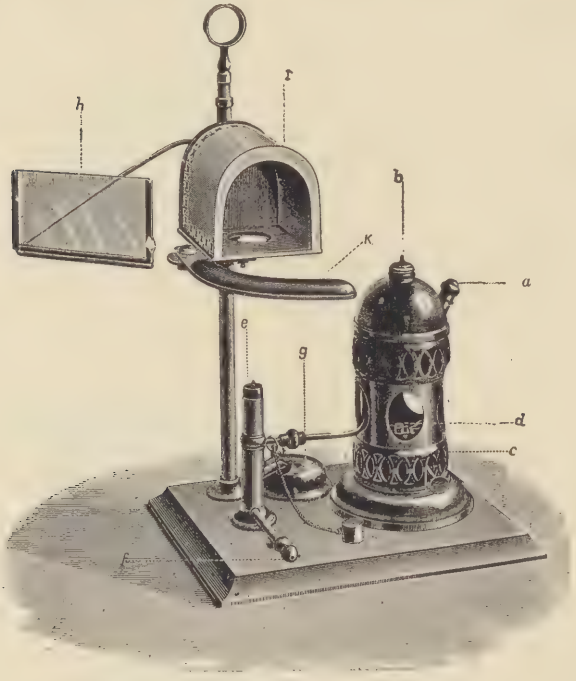


Fig. 220

Mitchell's electric furnace (Fig. 218) consists of a small box having an iron support. In the middle of the box is an opening $2\frac{1}{2}$ cm. square. The interior of the box is filled with an asbestos composition in which platinum wires are imbedded. Through connection with the electric current

these wires and the mass of asbestos are brought to a glowing heat.

In the Jenkins gas furnace the regulation of the intensity of the heat is brought about by an adjustment of the valve of the blow-pipe to a scale with millimeter divisions; and in the alcohol furnace by raising or lowering the position of the lamp, while in the electric furnace we effect the same object by breaking the current as already mentioned, resulting in the more gradual increase of the heat or by introducing a rheostat into the circuit.

FIG. 221

The question has been much debated whether when practicable one should use the electric furnace in preference to the Jenkins furnaces. The two Jenkins furnaces seem to have an essential advantage in respect to uniformity of heat and the flowing of the porcelain. Moreover, the fillings can be fused in a shorter time, which to a busy man means a considerable saving. The same results, however, can be obtained with the Jenkins furnaces. In small places, where electricity cannot be had, the question need not come into consideration.

In using the electric furnace it is not necessary to cover the impression with the nickel cap, since no soot is formed in an electric furnace, an advantage deserving consideration.

A slight change must be made in the shape of the fusing cup for use in the electric furnace. Cut off the cup and wire from the handle, hammer the wire flat and bend it to the shape shown in Fig. 221. As the cup does not correspond in size with the opening of the furnace, the sides may be bent a little to admit of its being easily passed in and out.

Methods of Fusing.—The process of melting is the same with all these furnaces. Usually three or four fusings are sufficient, but in making large contour fillings a greater number are sometimes necessary.

FIG. 222

FIG. 223

For the first fusing fill the impression to the edge with the porcelain powder (Fig. 222), but do not let it fuse entirely; and as soon as the mass has contracted and run together remove from the furnace. At this stage the surface of the porcelain is rough and has the appearance of a biscuit; although the impression was filled to the edges with powder it has now so contracted that the bottom is scarcely covered (Fig. 223).

Dip the bottom of the cup in water, to cool it, *taking care that no water gets into the cup.*

Then with the drop tube let alcohol flow upon the filling from the edges—*not fall directly upon the filling*—and add

more powder paste, pushing it with the brush into all the little depressions. *For this purpose the consistency of the paste should be very thin.* When certain of having filled in the paste wherever needed, we let one drop of alcohol fall directly upon the impression, then fill up to the edges again with paste, burn out the alcohol, and fuse a second time.

We now hold the fusing cup as long in the flame that the mass becomes thoroughly fused and the surface smooth and shining.

Fig. 224 shows the filling after the second fusing. The porcelain enamel has now attached itself to the edges in two places, above and below, but on either side it has drawn away. These places, after cooling the cup, must be filled out

FIG. 224

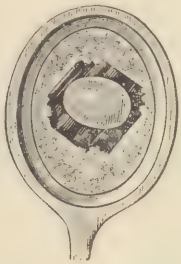


FIG. 225

as before described. Now follows the third fusing. By turning the cup during the fusing one can direct the flow of the porcelain toward any point desired. In the electric furnace we can set the cup aslant on the wall and attain this end more easily than with the other furnaces where the cup is held in the hand.

After the third fusing in most cases, especially after a degree of skill has been acquired, the filling will be finished. It is better in the beginning to use less powder at a time and fuse once or twice more rather than make the filling too high and be obliged to grind off something from the filling after it is set.

Fig. 225 shows a perfect filling after three fusings. We could judge just how much powder to put in to obtain the

desired height of this filling because we had in the imbedded impression the exact representation of the position of the cavity in the tooth. We would again emphasize this point: Allow so much of the gold-foil to overlap the edges of the cavity that you have this relative position before your eyes while melting and so may be able to easily determine what quantity of powder to add to make a perfect contour.

Use of Gum Colored Porcelain.—We now call attention to another use of the Jenkins powder. We often have occasion to fill front teeth whose defects not only extend under the gum, but also, on account of the recession of the gum, require a more complicated restoration. Fig. 226 shows such a tooth. For that part of the filling which is to supply the place of the normal gum tissue we can best use the gum-colored porcelain powder supplied in the Jenkins outfit.

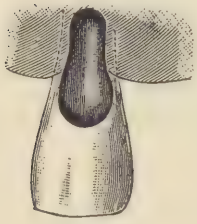


FIG. 226

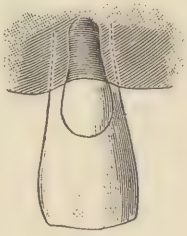


FIG. 227

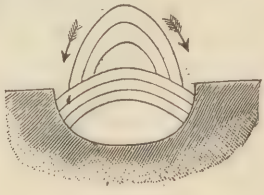


FIG. 228

Fig. 227 represents this tooth filled with porcelain enamel, the gum being restored in form and color by the use of the rose-tinted powder, giving the tooth its natural appearance.

If in such cases the defects are very small, and yet from their position at the necks of the teeth it is desirable to use the gum color for appearance sake, it is recommended to make the first fusing of some other color and flow the gum color over it.

Although the Jenkins Enamel can be readily ground away and beautifully polished, yet by doing this we sacrifice the original luster obtained in fusing which no polishing can restore.

Fusing for Contour Fillings.—The fusing process, represented in Figs. 222 to 225, is very simple; it is much more difficult when we have contour fillings to make. In such cases one must *take care in the second fusing not to allow the powder to flow to the edges.* Fuse as shown in Fig. 228, by layers, in order to prevent the mass from flowing over the edges. First fuse in the shape of a flat ball at the bottom of the impression, adding successive layers; although the cut shows this only schematically, yet it is a plan that can be very nearly effected in practice. In fusing we build the powder up higher than the real contour requires; it flows in the direction indicated by the arrows, so that we obtain just the desired contour. We mentioned in describing the taking of the impression that, in order to have, while fusing, a certain guide as to the form and size of the piece to be built out, one should, after removing the gold-foil, model in gutta percha upon the cavity the desired restoration, harden this model and keep it in sight in order to know exactly where to place the porcelain powder during the fusing process. By following this method we avoid building out the contour in a false *direction*, a misfortune which cannot be remedied after the filling is finished. The more carefully one goes to work at the beginning of the fusing process the more successful he will be. To become thoroughly familiar with all the properties of the material and the several stages of the fusing process, previous practice is of course essential.

THE PREPARATION OF CAVITIES AND OF THE COMPLETED FILLINGS FOR INSERTION AND FASTENING IN POSITION.

On completion of the fusing process we let the porcelain cool off and then dip it in cold water; this last for the purpose of more easily detaching the gold-foil. With the tweezers we cautiously separate the foil from the filling, beginning at the edges, *which we must avoid injuring.* This can usually be accomplished without difficulty; if, however, as sometimes happens, the foil does not come away in one piece but remains partially clinging to the reverse side of the filling, we

remove these bits with an excavator. The filling when ready for insertion should be *entirely free from particles of gold.*

If there has been a rent in the impression, we look for the place where the porcelain has united with the asbestos while fusing. This is readily discovered as a rough excrescence, which is to be removed with a corundum stone, since otherwise the filling may not fit the cavity.

We now place the piece in the cavity to ascertain by examination with the lens—in cases where the cavity extends to the palatal surface by help of the mouth mirror, if it fits the margins closely at every point.

Though we may hold large fillings in the pliers, it is often impossible in the case of small ones. We can manage by using a broken plugger with the rough end dipped in mastic. It is well to lay a saliva apron, or towel, about the patient while handling the filling, to avoid dropping the filling on the floor and thereby losing much time in hunting for it.

Undercuts in Cavity.—The next item of procedure is to provide the cavity with undercuts for the retention of the filling. Since the making of undercuts, especially in labial cavities in front teeth, is often painful, on account of the nearness of the pulp, it is well to use an obtundent, such as menthol in absolute alcohol, in the proportion of 2:1, Validol camphoratum or pure carbolic acid.

In every case *use very sharp instruments and dry out carefully beforehand with hot air.*

For making undercuts use either rose or wheel burs. Do not make them too near the margin, but more toward the bottom of the cavity; when the filling fits well it is enough that it has a good hold at its base.

Undercuts in Fillings.—The filling must also be furnished with several undercuts, made to correspond, when practicable, with those in the cavity, thus forming a ring which, filled with cement, will surround the filling and give secure hold. Fig. 229 shows a section of a tooth filled with porcelain where the undercuts correspond as aforesaid.

For making undercuts in the porcelain, thin nickel disks, of various sizes, covered with diamond dust, are used (Fig. 230). Those made by Ash & Sons are the best for this purpose,

being more durable than other makes; but it is important to keep the disk wet while in use, since otherwise they become useless at once.

The undercuts in the filling should also not be made too near the edge or the filling may break under the pressure of forcing it to place, though ever so moderately applied.

There are three kinds of undercuts used for the filling, the most common being a groove encircling the piece (Fig. 231);

FIG. 229

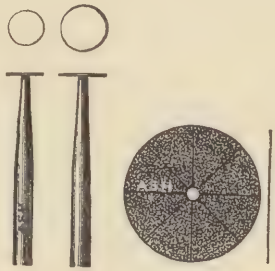


FIG. 230

FIG. 231

FIG. 232

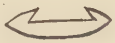


FIG. 233

for specially large fillings, as in the building out of contours, several parallel grooves (Fig. 232); and, lastly, the cutting out the center of the filling, as shown in Fig. 233, a method adopted for flat fillings.

In order to make these cuts the bit of porcelain is held with thumb and finger of the left hand, having previously moistened and dipped the filling in pumice powder to prevent slipping, and the groove cut with the diamond disk in the engine, using as little pressure as possible.

After making the undercuts wash the filling carefully, dry with a napkin and hold it over an alcohol flame to make sure that no moisture is left in the undercuts. It may happen that too quick heating of the porcelain may crack it, in which case one can take a new impression of the cavity, lay the broken pieces into it and re-fuse. Since some of the material has been cut away in making undercuts, it will be necessary to add some porcelain powder before fusing to insure the original height of the filling. The advantage of this is that it saves a threefold fusing.

Setting the Filling.—The filling is fastened into the tooth with cement. Those cements should be used which have the finest possible powder and which do not harden too quickly.

If on trying in the filling one finds it too light or too dark, it can be partially remedied by using respectively a darker or lighter cement, sometimes by mixing the phosphate powders. The mixing of the cement requires the most thorough incorporation of the powder and fluid, since the smallest lump in the cement will cause failure. The consistence of the cement must be that of cream, but on no account thinner, or it will not harden with sufficient strength for permanency.

Put a small quantity of cement into the cavity and distribute it into the undercuts with a suitable instrument. Then with a small and thin spatula fill the undercuts in the porcelain filling with cement and set it in place. Put in first that side of the filling which lies near the cutting edge and press gradually to place, so that the superfluous cement may be pushed out before the filling. By so doing one prevents the lifting of the filling by any air that may have remained in the cavity.

It is not necessary to use a great quantity of cement in the insertion of a filling. It suffices to fill the undercuts and to have enough that a little overplus be visible, oozing out at the edges of the filling. This overplus is removed with a narrow linen tape. The filling is then held firmly in place until the cement begins to harden.

It is best not to remove the rubber dam or mouth napkin until the cement left on the mixing plate is quite hard. If

obliged to admit saliva sooner, melt over the filling and margins a thin coat of paraffin, under which the hardening process will continue undisturbed. I cover *all* fillings with such a layer of paraffin, which, with the remaining particles of cement, is afterward removed by the patient in the act of brushing.

With practice one will rarely make a filling that does not exactly fit the cavity. Should it happen, however, that a filling is too high, or that the porcelain has flowed over the edges, one can remove the superfluous part with corundum stones and sandpaper disks (if one does not prefer to make a new filling) either before or after setting in place; in the latter case after a day or two. For polishing the surface roughened by this grinding, use sandpaper disks for approximal and Arkansas stones for labial and buccal positions.

Sealing the Cavity.—We wish at this point to contradict the statement often advanced by opponents of porcelain fillings, viz.: that a porcelain filling never properly seals a cavity, since there is always a space of the thickness of the gold-foil between the filling and the walls of the cavity; the cement which fills this space must soon be dissolved by saliva, leaving the tooth unprotected from secondary decay, and the early falling out of the filling is inevitable. How mistaken this opinion is we shall attempt to show by means of the three following illustrations:

Fig. 234 shows a section of a properly prepared cavity. Fig. 235 the same cavity, in which is laid the filling still enclosed in the goldfoil impression. (The goldfoil is here purposely represented thicker than it actually is.) In Fig. 236 the goldfoil is removed, and the filling lies in the cavity without it.

Although *on account of the thinness of the gold-foil there is no space left, worth mentioning, between the walls of the cavity and the filling, yet since in the case of properly prepared cavities the fillings, after the gold-foil is removed, sink deeper into the cavity to an extent corresponding to the thickness of the gold-foil, this space consequently disappears entirely and there is barely room left for cement.*

In order not to keep the patient in discomfort from the

rubber dam while the cement is hardening, one can draw the dam over the tooth, as shown in Fig. 237. By means of this arrangement the patient can wait in a neighboring room while the operator attends to another patient.

FIG. 234

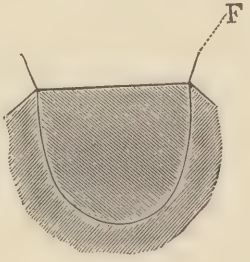


FIG. 235

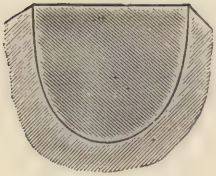


FIG. 236

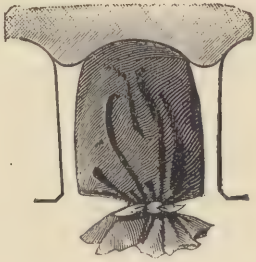


FIG. 237

APPLICATION OF "PORCELAIN ENAMEL" TO THE RESTORATION OF THE LARGER DEFECTS IN TEETH.

Besides its use for fillings of ordinary size and form and for restoring the contour, there are many other cases in which porcelain enamel can be employed, such as defects from traumatic causes or where large portions of the tooth have been destroyed by decay.

In cases where formerly the only method possible was to set a crown, the same or even better results may now often be obtained by the use of this enamel. Of course in such cases

one must carefully take into consideration whether the bite may endanger the durability of the work.

If the bite does not in any way interfere, one can replace large portions of teeth with porcelain enamel without anxiety. The patient will not be obliged to take more care in using teeth built out with porcelain enamel than he would with a Richmond crown, which we often use in such cases.

Before we proceed to the description of these cases, we would call attention to the principle that in this work *the depth of the cavity should nearly correspond to the size of the contour to be built out,* in order that the porcelain may have a firm hold (Fig. 238). It is not absolutely necessary to anchor it with posts or stays; indeed, in many cases their use is disadvantageous in relation to durability.

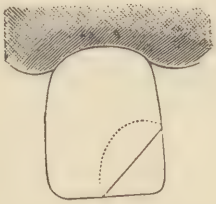


Fig. 238

From the many cases in which large defects have been restored by the use of porcelain enamel in the last few years, we select only the following for description here:

Case I.—A locksmith's apprentice fell through a glass roof and broke his right superior incisor. The pulp was exposed and the patient experienced great pain on opening his mouth. He came to the Breslau Dental Institute and was sent to the operative department under my supervision. The fracture ran from the mesial wall rather near the gum obliquely downward to the distal wall. The first thought in treating so great an injury was, after destroying and removing the pulp, to set a Richmond crown, but we decided against it, since this kind of fracture did not demand an operation that should remove the whole crown to the root.

At the first sitting by using *Anestile Bengué* the pulp was

removed, and for several days the pulp canal was treated with iodoform-ether, since the shock had induced a slight irritation of the peridental membrane. The root canal was then filled and the tooth prepared for the insertion of a large piece of porcelain.

Case II.—A young girl of fourteen came under my care for treatment of the right superior incisor, destroyed by decay, as shown in Fig. 239. It was the express wish of the parents not to have a Richmond crown, so we were obliged to make a porcelain enamel restoration and succeeded extraordinarily well, as appears from Fig. 240.

Fig. 239

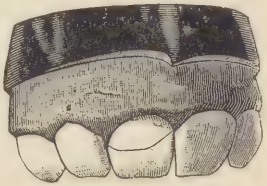


Fig. 240

Case III.—This case needed the restoration of a front tooth. It had been filled with cement and became discolored. After excavation there was scarcely anything left of the labial wall but the enamel. When the porcelain filling had been set, the original form and color were restored, and the patient was able to use the tooth as formerly. Figs. 241 and 242 show the tooth before and after treatment.

Case IV.—This patient came to have an artificial piece made. The incisors were all gone; both cuspids were partially destroyed by decay proceeding from the points and had been filled with gold. The plate which the patient was wearing had been constructed in relation to these shortened cuspids, and the appearance of the short teeth was unpleasing. On touching the gold fillings with an excavator, we found them ready to fall out, and therefore removed them and restored both cuspids with large and deeply seated porcelain fillings. Now that the cuspids had their original form, we could use teeth of normal size in making the new denture. In this

case we had also the opportunity to use porcelain enamel in another way. In trying in the piece it was observed that the root of the left upper incisor (that of the right was absent) had altered its position in the course of time and lay inclined toward the cuspid in such a way that a part of it came into view between the incisors of the artificial piece. In order to get rid of the blemish, porcelain enamel No. 18 (gum color) was fused into the space between the two artificial incisors, and thus concealed the root from view (Fig. 243).

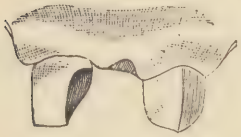


FIG. 241

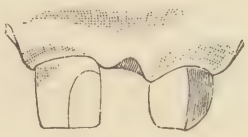


FIG. 242

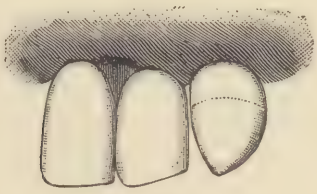


FIG. 243

Many such cases could be described, but these are sufficient to show that porcelain enamel can be used to advantage for large defects.

Crowns.—In making *pivot teeth and crowns* good results can be obtained with the Jenkins enamel.

For a pivot tooth select first a platinum pivot that fits the root well and cut several retaining notches in it with a disk. Take an impression of the root and grind a tooth to fit. Bend the pins around the pivot, as shown in Fig. 244, and try pivot and crown thus joined in the root. If the tooth has been ground to fit perfectly, remove, and with a Herbst polisher burnish a piece of platinum foil upon the face of the root projecting from the gum. The position of the root canal

will be plainly marked. After putting some wax upon the artificial crown, push to place in the canal and, making sure that the crown has the proper position, withdraw carefully; the foil will cling to the wax (Fig. 245). Then imbed in a fusing cup which Dr. Jenkins has devised for this special purpose and which has a platinum spiral to receive the pivot (Fig. 246). Fuse porcelain enamel upon the reverse of the crown until it appears as seen in Fig. 247. The enamel will unite so closely with the artificial tooth that if the bite requires it it can be cut down nearly to the pins without impairing the durability of the tooth.

In constructing these pivot teeth we must beware of cooling them off too quickly, since artificial teeth crack more easily than the fused porcelain enamel.

FIG. 244

FIG. 245

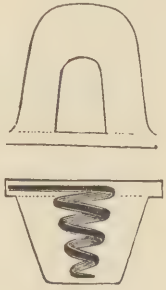


FIG. 246

FIG. 247

The Jenkins powder can also be used for crowns with success. In Fig. 248 is shown the root of a molar with a ring of gold fastened with cement. After removing the superfluous cement take an impression with gold-foil and fuse porcelain into it. Form the fissures with an instrument before the mass hardens.

Jacket Crown.—Dr. Jenkins, following an idea of Fenchel's, uses porcelain enamel in making the so-called "jacket crown." Fenchel puts a platinum ring on the root, which after trying in he gives the form shown in Fig. 249. Then he makes little cuts in the upper rim and bends as seen in Fig. 250. The ring can then be imbedded in asbestos and porcelain

enamel fused in it. By means of the platinum cut in parapet shape and bent inward the porcelain is held so securely that whole crowns can be built up with safety (Fig. 251).

In regard to this Dr. Jenkins writes as follows: "In many cases of a close bite, or for the restoration of fractured or undeveloped teeth where the pulp is still alive, this jacket crown can be used with success. It makes a very strong crown."

Dr. Jenkins is well satisfied with results obtained by the Fenchel method, both in respect to durability and beauty, and uses it in his practice.

Methods of Dr. George Evans.—Dr. George Evans, of New York, has also used the Jenkins enamel for other operations than filling. He employs it for covering gold or platinum crowns with a layer of sightly material.

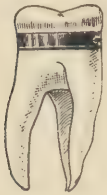


FIG. 248

FIG. 249

FIG. 250

FIG. 251

He sometimes cuts off the pins from an artificial tooth and grinds it so thin that only the outside labial surface remains; he then fuses this facing upon a gold crown, using porcelain enamel with marked success.

Molar Crowns.—Dr. Jenkins makes another interesting use of the enamel in preparing a crown for a lower molar. He made a platinum ring to fit perfectly the edges of the root; regulated the height of the ring, and took an impression of the ring and root; then soldered platinum upon the ring, making a cap that perfectly embraced the surface of the root. From the part of the ring above the cap a piece was cut out on the buccal side and a half molar, provided with a backing, was soldered on. Then, in order to make certain of correct articulation, the cap was tried again in the mouth.

The ring was now filled with porcelain enamel powder and the fusing continued until the occlusion with the antagonist was perfect. The porcelain united with the tooth most compactly. After another trial in the mouth the platinum ring visible above the gum was covered with gum porcelain enamel. Dr. Jenkins believes that he can make no stronger nor more durable crown than this.

From the variety of examples already given it may be seen how great a field of usefulness opens out for the extended use of porcelain enamel, especially if one most carefully takes into consideration all circumstances in making choice of it for each particular case.

We would once more point out how valuable, when properly and conscientiously used, this process is, both to our patients and to ourselves.

Its introduction constitutes for the dental profession an event of far-reaching significance, and insures for the discoverer the gratitude of all who regard dentistry not merely as a scientific handicraft, but rather as calling for the exercise of esthetic and artistic judgment and skill.

Conclusion.—When we take into consideration the difficulty with which nearly all our most useful filling materials were introduced into use, and read in the journals of earlier decades of bitter contests waged, for example, against amalgam, a material which no dentist today could spare, we can understand that there is likely to be much opposition to the filling of teeth with porcelain.

The mistrust of new discoveries and methods is to a certain degree excusable, since it often occurs that quite useless innovations are extravagantly praised. It is certainly desirable that warnings founded on experience should be published in the case of useless and worthless things.

When Dr. Jenkins, whose standing as a practitioner we have no need to certify, made known his method, after years of experiment, he not only explained it theoretically in a manner worthy of admiration, but also exhibited it practically in the mouths of his patients with brilliant and almost never failing success. Such a discovery, thus announced, may be received at once with a good degree of confidence.

That in this case confidence was completely justified is proved by the many satisfactory trials of this method made by many dentists and reported by them both verbally and in writing. So much the more astonishing is it that such really useful discoveries are often subjected to unreasonable criticism.

Although we have already emphasized the excellence of the Jenkins method and of the porcelain enamel, we wish in conclusion to combat some of these unfounded criticisms.

Jenkins's Porcelain Not Glass.—It has been claimed that the Jenkins material does not differ essentially in composition from the glass powders previously in use, *and that it melts over a Bunsen burner, which fact justifies the suspicion that it is nothing more than a glass compound.* Since we have been busy in these last years not only with making fillings after the Jenkins system, but have also been interested in studying the composition and the fusing-point of the porcelain enamel and of other compounds of like nature, we are prepared to give some particulars upon both these points, viz.: that the Jenkins material is believed to be a purely glass mixture and that it melts easily over a Bunsen burner.

Some of the porcelain mixtures which have come most into use were analyzed in the Chemical Institute of the Breslau University, the result being *that the Jenkins powder is shown to be almost identical in composition—the variation being very slight—with the so-called "high-fusing porcelain."*

As to the fusing of the Jenkins powder over a Bunsen burner, that is quite possible, since the flame of the Bunsen burner has a heat of more than 1300° C. in its hottest part, in which heat all the compounds used for porcelain fillings, including even the high- and low-fusing materials used by Ash in his artificial teeth, may be melted.

A series of experiments were made in the Physical Laboratory of the University, and the melting-points of the following porcelains noted with the scientific instruments in use there:

	Begins to melt.	Melting process completed.
Kaolith (Glogau)	At 693° C.	At 870° C.
Glass powder (Herbst) . .	" 790°	" 894°
Composition (Möser) . . .	" 810°	" 890°
Porcelain enamel (Jenkins) .	" 850°	" 910°
Ash's "low-fusing" . . .	" 865°	" 1000°

The figures marking the beginning of the melting are given here with addition of 20 degrees, because this was the temperature of the room.

From this table it clearly appears that materials having a still higher melting-point than any of these can be melted over a Bunsen burner.

Retention by Cement.—Prof. Hesse in his last lecture on the Jenkins porcelain filling before the Central Society (1901) mentioned the mistrust so often expressed by opponents of this method in regard to the retentive power of the cement. He is of the opinion that since the old glass and porcelain fillings have stood the test for years though held in place only by cement, it was not the lack of durability in the cement but of the material of which the fillings were composed that gave cause for complaint. So long as we have no more trustworthy material for fastening inlays in place, we must let what we have suffice. The most of the attacks on the Jenkins method are based on an insufficient freedom from prejudice or on an inadequate experience in the use of the material. Whoever will make himself acquainted with the brilliant results that have been attained will gladly enroll himself among the great number of the followers of this system. Only years of practice with a new filling material can qualify us to give a final judgment upon its capabilities and durability. One should not allow himself to be led to a premature condemnation on account of failures at the beginning.

Undoubtedly the future of operative dentistry is to be in large measure concerned with the employment of porcelain as a filling material, and we may expect, with increasing perfection in the methods and materials, that we shall in time possess that which is so much needed—a compound that will meet *all* the requirements that we must demand of an "ideal" filling material.

CHAPTER VIII.

GOLD INLAYS.

GOLD MATRIX INLAYS.

Gold matrix inlays have been used to advantage for many years, but the casting process has largely supplanted this method, therefore a description of these difficult and extensive operations must be considered unnecessary in this day of later improvements. It is an erroneous idea, largely prevalent

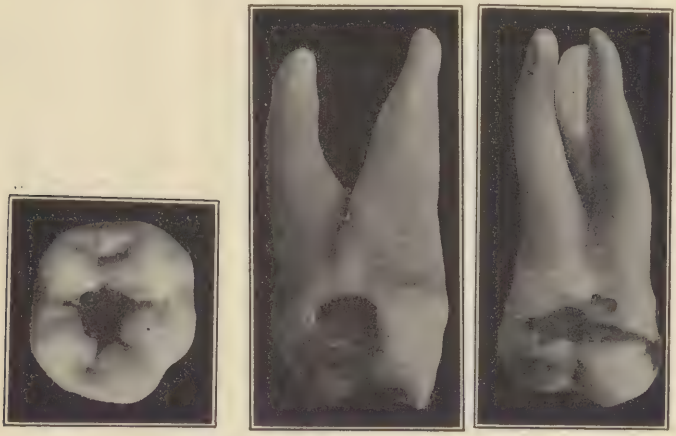


FIG. 252 FIG. 253 FIG. 254

FIGS. 252, 253, 254.—Cavities and restoratives suitable for and illustrating the gold matrix inlay method.

in the profession, that matrix gold inlays are entirely out of date, for there is no doubt of this work still having its place and that it is applicable and successful under certain circumstances. Its chief recommendation is the saving of much valuable time. One predominant reason why the matrix

inlay does not appeal to the general dentist is that phase of the operation which is the first consideration, viz.: the making of a matrix. Having that knowledge, the rest of the

Fig. 255

Fig. 256

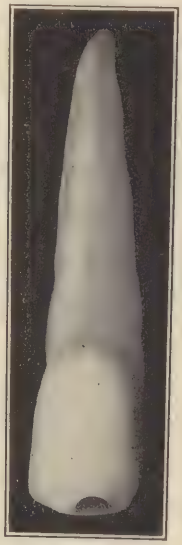


Fig. 257

operation is so simple that very little practice will accomplish most satisfactory results.

The process of making gold inlays is recommended for use in various positions where much contouring is not required, such as proximal cavities in bicuspids and molars, extending slightly between cusps. Occlusal surfaces between cusps, shown in Fig. 252, buccal cavities on same teeth (Figs. 253, 254 and 255) and small corners and incisal tips on anterior teeth which preclude the use of porcelain (Figs. 256 to 260).

Figs. 261 and 262 represent two forms of extensive proximo-occlusal cavities for gold inlays. Note the cement with step formation is shown by the darkened area and mechanical retention is made extending the cavity linguo-buccally.

Note the square edges and angular line at the gingival

border which is not permissable to the same extent with a metal matrix, but wax in a proper moldable state will adjust itself readily at these points. A chamfered edge is not

Fig. 258

Fig. 259

Fig. 260

Figs. 258, 259, 260.—Cavities and restorations suitable for and illustrating the gold matrix inlay method.

Fig. 261 Fig. 262

incorrect in many instances; in fact, some teachers recommend this as the proper method. It would seem that a burnished edge is easier obtained when the cavity edge has a

bevel, but it is one of those points frequently discussed and the square edge and the beveled edge preparation have each an equal number of adherents.

FIG. 263 FIG. 264

Fig. 263 is similar in form, but added retention is gained by extending the occlusal surface between the buccal or palatine cusps, as the case may be either upper or lower.

Fig. 264 is a simple form of mesio-buccal position. Fig. 265 represents a mesio-occluso-distal (M. O. D.) cavity, which is very common in molars and bicuspids, but not always possible to restore by a casting in one piece.

FIG. 265 FIG. 266

To draw the wax without change the axial and pulpal walls must diverge slightly toward the outer surface, as shown in Fig. 267.

Fig. 268 is a mesio-occlusal cavity very similar to Fig. 266, but with added retention of depression in the pulpal wall and in the cement steps.

FIG. 267

FIG. 268

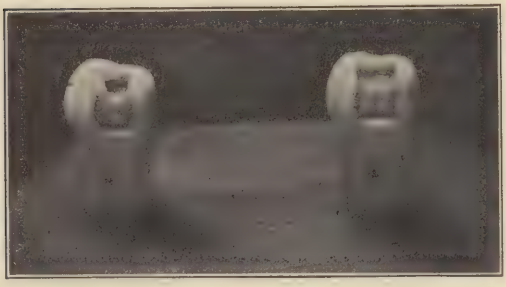


FIG. 269

FIG. 270

FIG. 271

FIG. 272

Fig. 269 and 270 represent cavities in bicuspids and the same directions described for the molar cavities of Figs. 265 and 266 are applied in these cases.

Figs. 271 and 272 are M. O. D. cavities in bicuspids, applying the same principles as described in Fig. 265. Fre-

quently the remaining tooth structure is too frail on these smaller teeth to resist the force of contact, then a reinforcement is recommended by squaring the occlusal tips of the cusps and extending the gold for their protection as illustrated in Fig. 272.

Figs. 273 and 274 show a frequent condition in practice. A large cavity in a devitalized bicuspid wherein an inlay is desired in preference to a crown. After canal treatment the crown is nearly filled with cement and then cut to a step formation. A hole is drilled through the cement near the center, but toward the enamel wall and sufficiently deep to reach the pulp floor and large enough to accommodate a pin of gauge 18 or 20, which may be platinized gold or iridio-

Fig. 273 Fig. 274 Fig. 275

platinum. The entrance to the drilled hole is countersunk with a large round bur which allows a greater bulk of wax to attach the pin to the larger surface forming the cavity. If the pin should not draw with the wax, heat the pin and insert it in the wax where the indentation is made and then force the combination back to place and finish ready for casting.

Fig. 275 shows a similar cavity but not so extensive, and retention is by means of a decided depression made by a round bur in the cement step.

In these latter positions the proof of the advantage of this work is the fact of the success of the method when every other material had been tried and failed after short use. An expert

gold operator may not treat this assertion seriously, believing that a hammered gold filling will be equally successful.

In many cases, particularly in teeth of hard structure, this is quite possible, but in frail teeth the application of this kind of inlay is simple, safe and satisfactory, and saves time.

The procedure for this work is to make a matrix of the cavities as for porcelain, either in platinum of the same gauge or gold of No. 30 foil, with the difference that as the matrix will remain part of the filling, it is not necessary to burnish or stretch the foil to position. It may be carried to the bottom and walls with no attention to folds or creases, but the edges must be well defined, as in porcelain work. When the matrix is made and while still in the cavity, mat

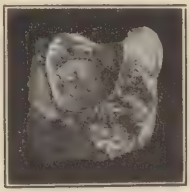


Fig. 276

or sponge gold of any description is loosely packed into it and in sufficient quantity to support the walls and cover the floor, and the break in the matrix which is then removed and two or three small pieces of 22 k. solder applied to the soft gold and melted with the blow-pipe (Fig. 276). The solder will run into the gold to the matrix walls, thus making the whole piece rigid. The excess matrix may be removed, the matrix replaced in the cavity and thoroughly burnished; it is again removed and with a fine pencil brush liquid rouge is traced over the whole outer surface to the cavity margin. This must be carefully done, for the slightest irregularity of the outline will be reproduced by the gold. The tracing of the liquid rouge prevents the gold from flowing beyond the margins, therefore it is a good rule to coat the underside, particularly if the matrix is of gold-foil. Small pieces of solder, or pure gold if so desired, are then dropped in connection with the cavity and melted with the blow-pipe. After

the desired form is secured the excess matrix is cut away and the inlay is ready for cementing.

Rowan's decimal gold No. 30 for packing the matrix has an advantage over mat gold because it is composed of a thin layer of platinum between two layers of gold, therefore it is only necessary to throw the flame on this combination while it is in the matrix and the gold portion immediately acts as a solder which unites the whole without any additional solder. This combination should be used only with a platinum matrix, and in any case the rouge should not be applied until after a trial fitting, because the burnishing will carry the tracing from the edges to the interior and prevent the solder flowing easily.

Cleanliness and care will obviate much trouble, for gold will not flow where there is the slightest deposit of rouge. Small tips and corners are contoured by the use of small pieces of gold plate cut to desired shape or melted into small globules, which extends the contour; these are afterward ground to shape. A little practice will insure very satisfactory results.

THE CAST-GOLD INLAY.

There have been many inventions in dentistry, but it is doubtful if any improvement was ever received with greater enthusiasm than that of the inlay casting method.

Dr. Wm. H. Taggart, of Chicago, has the distinct honor of being the inventor of the first appliance for this purpose, having demonstrated its possibilities before a meeting of the First District Society of New York, in January, 1907.

For twenty years the profession had been gradually accepting the inlay in its various forms, also the fact that a cemented filling had merits worthy of consideration; therefore this newer and more perfect process was received without reservation, with the result that almost every dentist is a practitioner of this method. The almost unlimited possibilities of the casting process have developed newer operations almost too numerous to mention, including inlays of all forms, crowns and various bases for such work, cast bridges, partial and full plates, dental splints and various appliances. In

fact, the ingenious dentist has by no means exhausted its possibilities of practical application.

The machines for performing this work have rapidly multiplied in design, and they are made in such variety of form and cost that no one need be dissatisfied.

Casting molten gold in various forms can be done in numerous ways, but the basal technic is the same in all instances, therefore the description as given by Dr. Taggart is necessarily authoritative, and is as follows:[1]

"In all my casting work, whether operative or prosthetic, I am using a special wax known as 'Taggart's Green Wax.' This wax has been made green in color because it will thus be easy to differentiate between the wax, the enamel and the gum tissue when working directly in the cavity; and while most excellent results may be obtained by taking impressions and making amalgam or cement replica models of cavities, manifestly no duplicate of the cavity, and no articulated model thereof, can be so accurate as the cavity itself and the patient's jaws, which must give the exact occlusion. A little practice will convince the majority that it is better to work within the mouth when making inlays.

"This wax is warmed in water not above 138° F. until it is thoroughly softened throughout the mass. It must not be warmed with dry heat nor manipulated with the fingers, with the idea that the softening can be hastened in that way. A piece the size of the stick and of length in proportion to the size of the cavity should be softened and carried in its original form to the cavity, and firmly pressed into the cavity with the fingers, allowing the excess to act as a piston in forcing it into all parts of the cavity. The patient should then close the jaw, biting firmly into the wax, giving the imprint of the opposing cusps. Then have him move the jaws, as in the act of chewing gum; this wears down all the high points and gives the correct occlusal form. All excess wax is trimmed away and the wax carved into the exact form desired for the completed inlay. A special quality of the wax is that it can be beautifully carved, remaining hard

[1] Items of Interest. April, 1908.

enough for this purpose even at the temperature of the mouth; and as the process exactly reproduces every form and line of the wax model, and as wax is more easily carved than gold, it will repay the operator to spend a little time, care and artistic skill in making the wax model. The wax inlay remains hard enough in the mouth so that it may be lifted from the cavity without change of form, and it can then either be held in the fingers for further carving, or artistic touches may be added when the wax inlay is mounted on the sprue, as in Fig. 278.

"Frequently there is considerable bulk of wax owing to certain conditions not always possible to avoid, which if reproduced in gold will increase the cost of the operation very noticeably. The wax can be reduced by melting the surface, which will be cemented. Considerable undercut

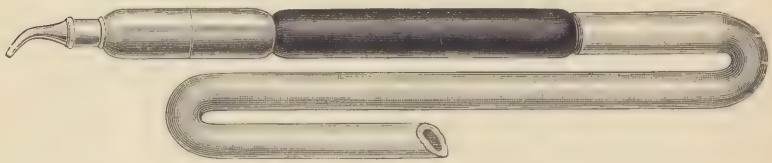


FIG. 277.—Roach's suction wax carver.

can be made which will increase retention of the inlay. The best instruments for this purpose consist of hollow points with rubber tubes attached (Fig. 277).

"The point is heated and applied to the wax, and sucking the tube will draw the melted wax into a small section filled with cotton. Electric points of various forms are also used, and the simpler method is a hot amalgam burnisher, wiping the wax from the point after each application.

"When finished the wax inlay is held in the left hand and the sprue wire in the right. Then heating the sprue wire until it will melt its way into the wax the two are brought together, as shown in Fig. 279.

"The inlay and sprue wire are then placed in the crucible former, as in Fig. 278. The investment is properly mixed in the following manner:

"The large cup on the measuring device (Fig. 280) is to be filled lightly with investment and scraped-off flush with a straight-edged, silver-plated dinner knife, which can be used as a spatula.

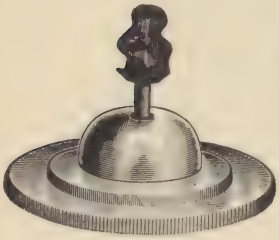


FIG. 278

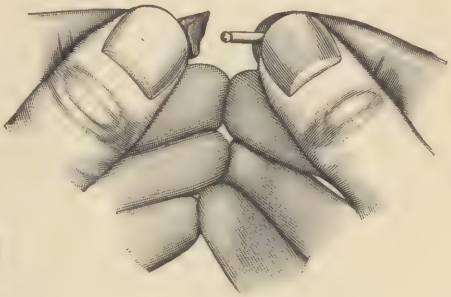


FIG. 279

"The small end of the measuring device (Fig. 280) is filled even full with water and the two mixed together. For the large flasks just double these quantities. Then place the rubber plaster bowl in the position shown in Fig. 281, and jar it on the bench, rotating it slowly in order to smear the whole inside of the bowl with a thin layer of investment.

FIG. 280

This allows all air easily to work out through this thin layer. Carefully place the investment on the inlay in such a way as absolutely to avoid all air bubbles being caught in the investment, because these air spaces would be filled with gold in the casting.

"This stage is represented by Fig. 282. Apply the flask, round edge down, and pour the investment until the ring is

full. Do not jar the investment to make it go to place; this only causes the contained air in the investment to form large bubbles against the wax. Rotate the flask slightly and cover and the mass will settle; then, if necessary, add more

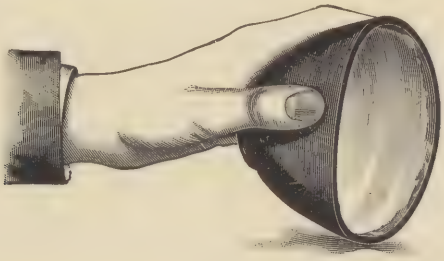


Fig. 281

investment and turn the flask over on to some smooth surface and press the excess to place, allowing the excess to squeeze out of the small hole in the flask. The investment should be allowed to set for at least fifteen minutes, or it can be set

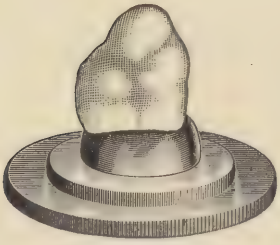


Fig. 282

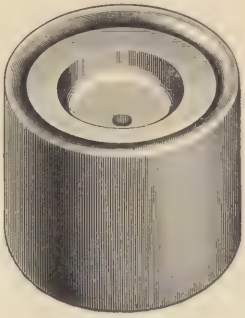


Fig. 283

aside for an indefinite period; but better results are obtained by drying out as soon as the plaster has set. When ready for casting the crucible former is removed, as in Fig. 283, the flask is set over the Bunsen flame, and at first slowly

dried out; as soon as the steam ceases forming a higher heat can be turned on and the wax burned out thoroughly.

"It is now ready for the casting machine, and a generous button of 24 k. gold, at least five pennyweights, should be

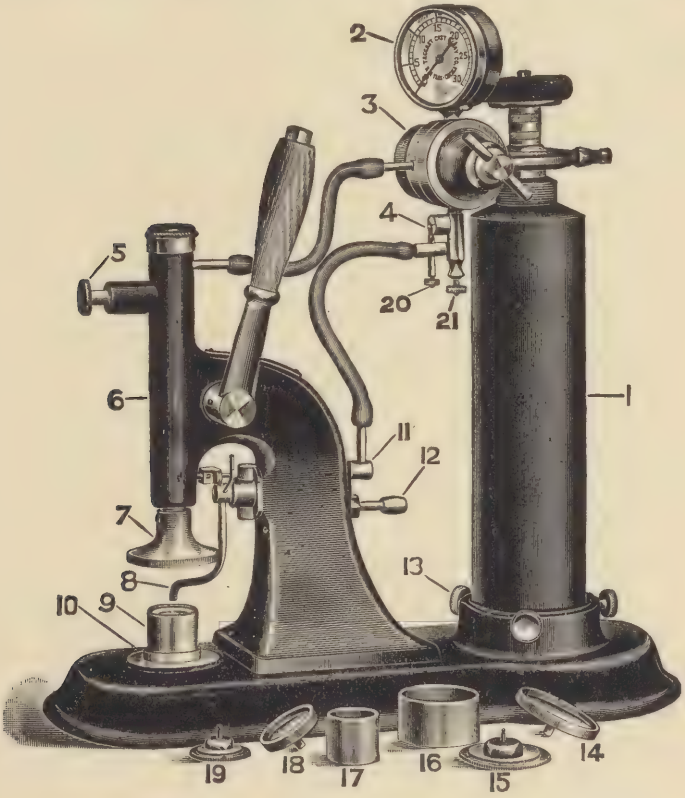


FIG. 284

placed in the crucible. As there is no waste in casting, it is always best to have plenty of gold in the crucible.

"Referring to Fig. 284, the machine is operated in the following manner:

"The flask *9* is placed in ring *10*. The city gas is con-

nected by hose to *12*. The nitrous oxid blow-pipe *8* is turned at right angles to the machine and the city gas lighted, making a smoky flame about four inches long. The handle to the reducing valve *3* is turned backward, or to the left; now open, with the wheel, the main nitrous oxid cylinder valve *1*. This allows the high pressure of the nitrous oxid gas, which in a full cylinder is one thousand pounds, to pass into the reducing valve *3*, and by turning the bar handle of the reducing valve *3* to the right, any degree of pressure can be indicated on the gauge, although five to eight pounds is sufficient. The needle valve *21* is opened to allow nitrous oxid to flow through *11* to unite with the city gas, which comes in at *12*. By mixing the proper proportion of nitrous oxid with the city gas a blue flame is made about three-quarters of an inch long. Now place the flask *9* in the machine ring *10*, using the tongs; then turn the blowpipe to the proper position to play on the button of gold, and when the gold is in a boiling state, bring the handle forward with a decided jerk, which will automatically throw the blowpipe *8* out of the way, and automatically bring the pressure plate *7* down air-tight on the flask *9*, and automatically hold the lever down by closing the lock *5*, and automatically start the alarm whistle *4*, which is regulated as to its volume of sound by the small needle valve *20*. The object of this alarm is to draw attention to the fact that the main valve on the nitrous oxid cylinder *1* is to be shut off when the casting is finished, or the nitrous oxid will escape over-night. The sustained pressure should be kept on top of the gold for thirty seconds, after which the flask can be taken out and put into water, when the investment can be washed off. The inlay should now be placed in 50 per cent. hot hydrochloric or full strength hydrofluoric acid, to make certain that all foreign investment is dissolved off.

"The excess gold is sawed off at the sprue and the filling mostly finished out of the mouth. It is always best to examine the cavity side of the inlay under a magnifying glass so as to see that there are no little beads of gold, which would prevent it going thoroughly to its seat. As these fillings fit the cavity so tightly, it is best to drive them to

place several times with a stick and mallet before setting, and when the cement is in place, seat again with mallet and stick.

"This repeated tapping with the mallet in different directions will seat an inlay better than it can possibly be done by direct pressure on the inlay. The margins can now be gone over with stones and disks of polishing tapes and finally polished. When prosthetic pieces are being made, Taggart's green wax should be kept at a workable temperature by frequently holding the model and wax in water at 138° F.

"The possibilities for displaying ingenuity in constructing different prosthetic pieces are only limited by the versatility of the dentist.

"The nitrous oxid blowpipe for this work has decided advantages over any other blowpipe flame, for the reason that the gold can be melted so much more readily and brought into a more fluid condition and shot into the mold while the mold is practically cold, and not unduly expanded, as the investment would be if the gold were melted by the ordinary blow-pipe."

In a further communication Dr. Taggart states:[1]

WAX AND ITS TREATMENT.

"To be scientifically correct, a wax must be of such a nature as to be sluggish in movement, and which, at the temperature of the mouth, will absolutely break before it will bend. Without this quality there is no certainty that it has not become distorted, especially in complicated cavities.

"With soft waxes and the use of cold water it is possible to obtain fairly good results in ordinary cavities, but where there are any complications, such as are found in M. O. D. (mesial-occlusal-distal) cavities, the wax, as soon as the cold water is withdrawn, almost immediately resumes the temperature of the mouth, and while it may be easily withdrawn from the cavity, there is no telling to what extent it may have been bent, and this condition will not give a high percentage of successes in the places which should be the most accurately filled.

[1] Items of Interest, July, 1911.

"I have made eleven hundred and fifty different mixtures of waxes and gums and did not succeed in having continuously successful results until a wax was obtained which possessed the foregoing properties, but others seemed to think it required too much effort to get it to a workable condition. From the start it was found that the uniform plasticity throughout the whole mass could best be obtained by warming in hot water, but in trying to do this in a hurry the surface was made softer than the internal mass; yet if sufficient time were used to allow the whole mass to be thoroughly heated throughout, excellent results were obtained. To surmount the problem of heating the wax properly, I have devised an automatic electric heater (Fig. 285). When the instrument is set to work so as to give the proper degree of plasticity, it will always duplicate this temperature, but it must be allowed time to arrive at this correct temperature, and by making it automatic this can be accomplished to a nicety. As soon as I commence to prepare the cavity the heater is started, and this gives ample time for the wax to be thoroughly warmed throughout its mass, so that when the cavity is finished the wax is ready to be used, without loss of time, with annoying conditions removed, and with continuously duplicated and gratifying results. This instrument has brought the molding of the wax pattern down to practically a scientific basis.

"This instrument (Fig. 285) has as a heating element a 16-candle-power lamp, with a carbon filament. The carbon filament is being abandoned for lighting purposes, because it furnishes more heat than light. The Tungsten filament furnishes more light than it does heat. For that reason I have used the carbon filament to furnish the heat.

"It works on the following principle: There is a glass disk, which can be turned to one side in order to place the wax on it. As all the heat comes from one direction, a flat metal disk or surface would receive heat upon its upper surface and the under surface of the wax would be cool. I found that one of these disk glasses is thin enough so that as the heat strikes it it is reflected back so that the under side of the wax is warmed as well as the upper. I have had wax in the instru-

ment for fifty-six hours at a time, and when I examined it it was plastic in its mass and no more heated on the upper than on the lower side.

FIG. 285

"The electric heating apparatus was hard to control automatically if the current were allowed to go in a continuous path, but by adopting the principle I have used, of having the heat all on or all off, it permits the intermittent heating of a thermostat. It heats the thermostat, which, as soon as it gets a little too warm, breaks the electric circuit. When the electric circuit is broken the thermostat begins to cool down and the thermostat throws the current into the lamp again. It works by excessive heat, and it shows there is not a one-hundredth degree of difference in temperature between the surface on one side or the other. Sometimes it will flash 50 to 60 times in a minute; sometimes slower. The reason is, it is a very sensitive test of the voltage that is passing through the wire. It has been often noticed that when the lights would go up high it would make the room light enough. When the current is at a high voltage the lamp is heated more, and that works the thermostat quicker, and as soon as it is worked quicker it immediately drops down. The movement is caused by that voltage.

"The wax is placed on the glass disk and the even temperature throughout the whole mass has a great deal more to do with the correct molding of wax in a tooth cavity than appears. It is peculiar, but a soft, wobbly condition of the surface of the wax will invariably make it shrink from the cavity walls; whereas, if the wax is of a uniform texture, it will move to its place in an exact way, and there will be no change in form when it cools off.

INVESTMENTS FOR CAST INLAYS.

"This problem of investments seems to have caused more trouble than even the wax problem did, and justly so, as after the pattern, which must be accurate, the mold must be scientifically correct. A great many of the faulty adaptations, aside from those caused by distorted patterns, come from improper investments, or good investments improperly handled.

"One writer has given several pages of meaningless statistics about investments. I have not been able to

fathom their meaning, because, if investments are tested under conditions which should never be allowed, no number of pages of statistics can make me believe that this would be a scientific treatment of the subject. For instance, temperatures of 1000° are mentioned; as a matter of fact, such a temperature is so far beyond the requirements that the article loses weight as a scientific treatise. The temperature required in order to do scientific casting should never be higher than just enough to burn out the wax. Anything beyond this is absolutely harmful and brings the investment to a temperature where the ingredients themselves are burned and give off gases which are very objectionable in a mold.

"The temperature in the flask at which casting should be done has not been thoroughly understood. A hot flask is an expanded flask, and an expanded flask means an expanded hole inside, and an expanded hole means a misfit casting.

"I think one of the most scientific reasons why I have such continuously satisfactory accuracy in the fits of my cavities lies in the fact that I never cast in a mold hotter than the temperature of the room. In other words, always allow the flask to become cold. This gives two conditions, both important. One is, the mold is not distorted, and the other is, that the metal flask, in being allowed to come back to a normal temperature, hugs the investment tighter and gives it a support which is very helpful in resisting the pressure from within.

"Most of the handling of investments is done in a very unscientific way; as a rule, there are no two times that the conditions are made the same. Experiments in sufficient number should be made to determine the correct quantities of water and powder, and then these proportions should invariably be duplicated; otherwise, how can uniform results be obtained? There must be some proportion of water and powder in any investment, good or bad, which is the correct one for best results with that particular investment, and when this is determined it should invariably be duplicated. This can only be done by weighing the ingredients and not by measuring, as it is impossible to always get the same

quantity of powder in a vessel unless it is weighed. A little pressure or tapping will alter the quantity away beyond reason. From the start I have insisted on exact weighing of both water and powder, and this accounts again for a high percentage of uniform results in my work. A rule of thumb method will never accomplish scientific casting. A little water and a little powder, and if too thick a little more water; and if this time it is too thin, then a little more powder will never give two mixtures alike, and if the consistency of mold is not twice alike, the casting results certainly cannot be duplicated.

"A good investment should be so compounded as to make it possible to pour it into the flask, and have plenty of time to know that the wax is thoroughly surrounded. A thin investment also allows the contained air to more easily escape. When I was using a thick investment and manipulating it hurriedly, as was necessary, I would find pimples on the gold far in excess of what I thought was caused by the contained air in the plaster ingredient, and I came to the conclusion that gases must be evolved after the investment was in its place in the flask. By making a proper mixture of ingredients, it now allows me so to manipulate the material that any contained air or gases are allowed to escape before the flask is filled.

"In order easily to weigh and mix investments to get uniform results, I have devised several instruments by means of which this object can be obtained and scientific casting has taken a long step forward.

INVESTMENT MIXER.

"This apparatus was among my first instruments for mixing investments. It is an open tube and a movable other end to the lever. In the center is the fulcrum. There is a movable weight. Imagine the fulcrum at a certain point. On top of it I have a spirit level. Without that it would be impossible to tell with the eye whether this end or that end was too low. If either condition existed, correct proportions of water and powder could not be obtained. As soon as the spirit level comes to a center, that is the correct amount.

"This is a movable weight between two nuts. When it is to the left there is a certain amount of powder, and when to the right there is a certain amount of liquid.

"The spirit level shows the weighing beam is level. I now move the weight over to the right side. That brings it out of balance. By squirting the water in, and bringing it back to balance, we have the correct quantity of water.

"Those two ingredients are in there in the proper proportions, and those conditions can be duplicated every time, and after the proper proportions have been found, the advantage can be seen. It is liquid enough to shake it and get the ingredients properly mixed.

"The element of time comes in. These gases seem to be evolved from the chemical action of the water on the plaster, hence the liberation of contained air and gases. The plaster taking up the water, whatever gases or contained air there may be in the powder or water, are given a chance to be eliminated by rolling it from one end of the tube to the other and giving it a slight tap occasionally. As it is rolled in this way the gases come to the surface. They have a great attraction for the water, but a little tap or jar will break them loose, and then the process is repeated and the rotary motion given. Three or four minutes of time can be consumed in this way, and the investment is still in a workable condition.

"When it is ready, the inlay which is on the crucible former is carefully painted over with a small camel's-hair brush, so that there is no air pocket concealed in any angle, and the investment is then poured into the flask. It is in a liquid condition, and is absolutely free from all the gases and bubbles that have formerly caused annoyance, and which invariably produced the little nodules of gold on the surface of a filling. It is easily seen how a thick investment could confine this air, and the air, having some buoyancy, will rise somewhat; but it has not enough buoyancy to come out, especially when it strikes the under side of the inlay. Any jarring of the flask at this time is the worst thing that can be done, because the colonies of small bubbles of air and gases congregate and cling to the under side of the wax

pattern. The investment stays thin for ten or eleven minutes, and apparently it is so liquid it never will set; but when it is looked at again after turning aside for a moment and forgetting it, it has set. It turns rapidly from a liquid to a solid. At the end of twenty minutes it is ready, even when mixed in this liquid form to place on the fire.

Fig. 286

"In order to mix these ingredients properly I felt as though the instrument was rather crude, and that a more accurate and automatic instrument should be made (Fig. 286.)

"In this vessel I mix the ingredients. There is a spring that allows the rod to be shortened. It was put in a little hole in one side and one on the other side. In the other device there was a chance to change the length of the lever in the scale beam. In other words, in dropping the powder into it the bulk of it would pile up on one side. That would make the beam longer, and a true measurement would not be obtained. If it were possible always to place it absolutely in the center it would weigh properly. The liquid takes care of itself. I made a movable joint in this, so when the powder is put in, it tips it over and brings the center of gravity below the point of support.

"The instrument is handled as follows: I hang it on the fulcrum. The arm has a spirit-level in the top, the same as the other. The weight is pushed to one side, the powder is placed carefully; it must be remembered that a little too much powder or too much water will make it of such a consistency that it will not roll in the container, but will become sluggish and mushy. The weight is now moved to the other side of the scale beam. Water is poured in until it comes to a balance again. The spring is removed and the lid placed on and shaken up so as to get the ingredients mixed. It will be noticed that the arm leading off from it is placed at an angle. This is placed on the motor, and we have a cog motion here which reduces the speed of the container to about sixty revolutions a minute. This mechanism is an automatic one. In my work I allow five minutes for the mixing. Five minutes is better than three minutes, because every chance is given the gases to escape in this time, and the five minutes may be occupied with other work. I take the wax inlay after it has been placed on the sprue wire, start the automatic instrument, and then do the artistic carving and finish up the wax filling; and often I have plenty of time to do all the carving that is necessary while this mixing of investment is going on. By setting the clock at five minutes the mechanism revolves. There is a little jerking motion each time. This jar is to burst the air or gas bubbles. The bell rings and the machine stops automatically. The automatic device for stopping is nothing more than a snap switch placed on the

alarm end of the clock, so that the alarm movement is the one that throws off the switch.

"The material is now ready to be poured into the flask. It is of a much better consistency even in the few minutes I have mixed it—freer from air bubbles—than in any other way in which I can mix it. If it is jarred in a more violent manner more air is apt to be pumped into it.

"By allowing the disk to revolve alone the angle at which the container is set is continually changing, which keeps the liquid investment constantly changing its place and spreads it in a thin layer on the inside, and the jar bursts the gas bubble.

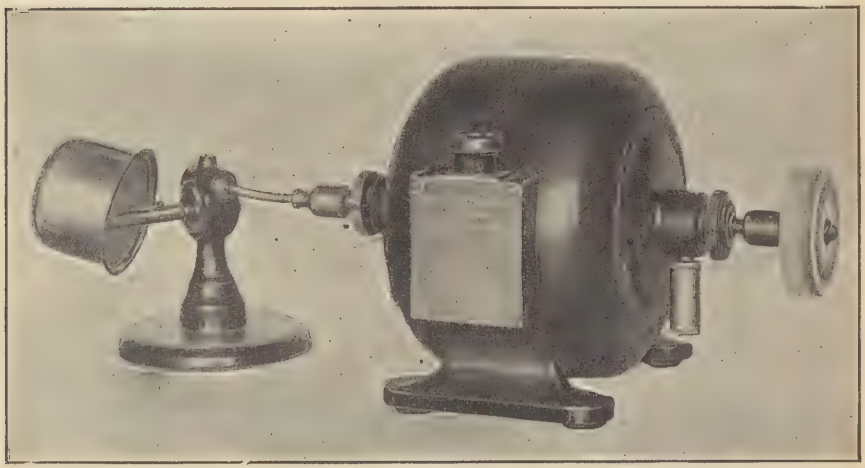


Fig. 287

"There is another automatic mixer (Fig. 287) that can be connected with any of the lathe motors. This is a Ritter. This machine works on the same principle as the other. As the mixing goes on for the requisite number of minutes the clock movement goes along, and the jarring motion is obtained. The fact that there is an alarm loud enough to draw attention to the fact that the work is ready, is better than the assistance of anyone in the mixing. It permits the work to be done identically every time.

METHOD OF REMOVING WAX FROM MOLD.

"The case is now flasked. It is seldom that wax has been burned out successfully twice alike. As this process takes considerable time and it is not considered necessary to watch it, there is great likelihood of overheating and spoiling the mold by forgetting it, sometimes leaving it on the flame for hours. If continuously duplicating conditions, as I have previously outlined, is of any importance in scientific casting, it is equally so in the simple burning of the wax. I have devised a burner for this purpose which does the work automatically and thus becomes a great time saver.

AUTOMATIC APPARATUS FOR BURNING OUT THE WAX.

"In this instrument (Fig. 288) I have three different degrees of flame. If great care is taken when the first low heat is put on, and plenty of time allowed for the water to be evaporated out of the investment, as much heat as is desired may afterward be put on and as fast as may be wished.

"This low heat is without signification unless it is confined. The swaying of the flame by draughts would mean continual variations of temperature. I put a tube over as a chimney to make the flame come to the top always and to prevent its swaying.

"On the back part of another alarm clock there is a disk which has three steps and a valve of special construction. This level first rests on the first step, and as it is set for five minutes the clock moves at that low heat and then drops on to the step next higher. That temperature is kept up for another five minutes, which precludes the possibility of any further moisture which might suddenly burst and destroy the investment. As time goes on—another five minutes—it drops off, and it goes up another step. That, we will say, is the third, and highest temperature. At the end of that

time another five minutes elapse and the switch goes off and the flame goes out.

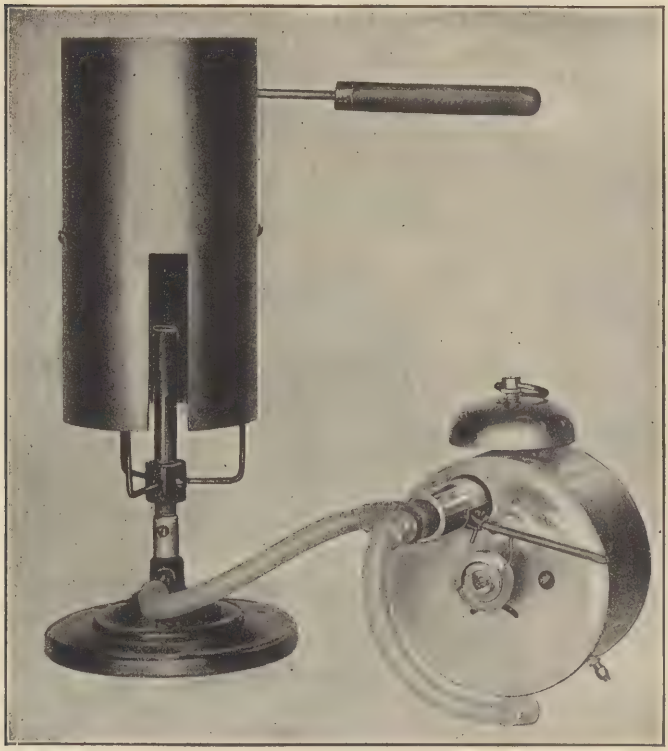


Fig. 288

GOLD FOR CASTING.

"The next phase of scientific casting concerns the gold itself. If there is any one thing more than another which has hindered the scientific casting of inlays, it has been the eagerness of the dentist to use all of the old refuse gold about the office. The question of saving on an average sized filling, say as large as one and a half pennyweights, would amount to ten cents when pure gold scrap is used. In the case of

22 k. scrap, fourteen cents would be saved on the filling, and in 20 k. scrap, about sixteen cents. For a filling of this size not less than ten dollars should be obtained, and not more than a hundred. Now let us see how this figures as to cost. If a failure occurs on account of using bad gold on a 22 k. scrap filling at ten dollars each, it would require seventy-one and three-sevenths fillings, and on the one hundred dollar filling, seven hundred and fourteen and two-sevenths fillings to come out even on that one failure. Real, ethical, scientific, artistic, humanitarian, and opposed-to-patents dentists cannot afford to prostitute themselves to this extent.

"So much for the commercial side. Now, as to the scientific aspect of knowledge gained and verified by exact observation and correct thinking.

"Dental golds are alloyed with either silver or copper, and in case of solders, zinc is used. It is a well-known fact that silver and copper, or any baser metals, readily absorb gases when melted, and these gases, principally oxygen, form oxids of the metal, and on cooling evolve these gases, which cause the blowholes, or porous cast. The elimination of these absorbed gases also causes the sputtering in alloyed gold, which does not occur when pure gold is used, as the latter in its melted state does not absorb gases; consequently, when cooled from the melted condition, it has no gases to squeeze out, and it is necessarily exceedingly homogeneous.

"While it is known that platinum is non-oxidizable, and might have properties helpful to gold, it must be borne in mind that platinum at these high temperatures has a very great affinity for silicon, and a piece of pure platinum melted in a crucible with but a small portion of silica will become very brittle. This possibly accounts for the brittleness of clasp gold when cast, as clasp gold is supposed to be alloyed with platinum.

"All of these conditions I have found out by practical experience, and have had them verified by expert metallurgists. What do these experiments mean? They mean that if cast inlay fillings are to be made in a truly scientific manner pure gold must be used. There are also a great number more of clinical reasons favoring the use of pure gold.

"But what is to be done in cases where more strength is required, as in bridge spans, plates, etc.? Choose the lesser of the two evils and use coin gold, which is alloyed with copper, and if not melted over and over again the gases do not injure its ultimate structure as they do silver, zinc and platinum.

"**Casting against Pick-ups.**—One more principle about gold should be mentioned, the casting of it to other pieces of gold which are in the flask.

"Without any experience except that gained by blow-pipe work, the first thought which seems to come to dentists

FIG. 289.—Jameson's casting machine.

when they wish to cast against gold is to bring both the golds to as near the same temperature as possible. This process absolutely defeats the object sought.

"In bringing the flask and its contents up to a bright red heat, the enclosed metal is brought to a temperature at which it oxidizes, and as there are no means of deoxidizing this surface, a less perfect union is obtained when the melted gold is thrown in than when the case is heated up to a temperature just sufficient to burn out the wax. This temperature does not absolutely burn all the carbon off the enclosed gold,

and as carbon is one of the very best deoxidizers, the gold is now in the very best condition to be welded to other gold. The proper scientific method in order cast to this gold is to bring the melted metal up to an excessive temperature.

"**Pressure.**—The pressure used is an important factor in scientific casting. It may be too low to do accurate casting, or, on the other hand, too high. The intermediate pressure which is just right can only be obtained by automatic controlling mechanism."

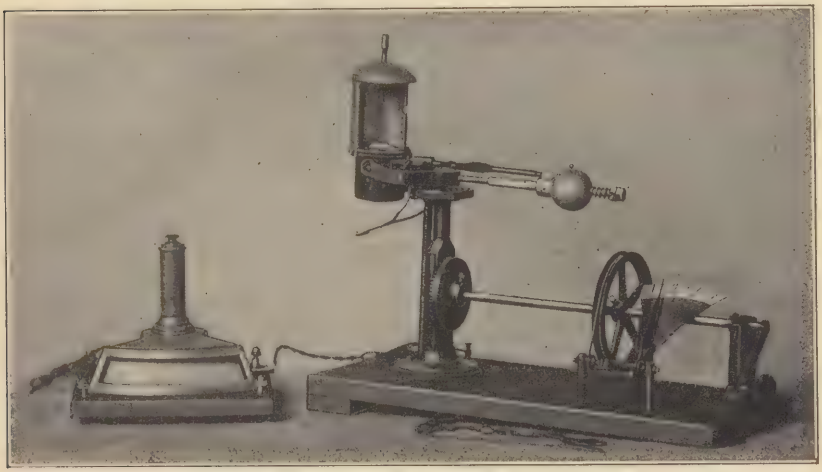


FIG. 290.—Price's casting machine.

The introduction of the Taggart machine was quickly followed by many others, some of them notably ingenious. That by Dr. Custer is distinctly different from all others because of the fact that the gold is melted by electricity. This machine has been withdrawn from the market, but was a favorite for some time.

Jameson's is again different because the gold is thrown into the mold by centrifugal force (Fig. 289). This machine is circular in form, with extended arms, on one of which is the mold and crucible for melting gold. These are set in motion by releasing a strong spring, forcing the arms to

revolve at a rapid rate, which throws the gold into the mold. This apparatus is very efficient. There are several others of the same principle used on lathes and home-made contrivances, which cast by holding in the hand and swinging in the air. Dr. Weston A. Price has devised a most interesting and effective electric casting machine, entirely different in design from all others of that kind, and as it is deserving of more than passing notice, Dr. Price's description is given:

"The centrifugal casting machine shown in Fig. 290 was designed both for experimental and practical work, and is particularly satisfactory and efficient for both.

"The gold is melted to the desired temperature in a crucible in a resistance muffle like the muffle of a porcelain furnace. The temperature of the gold is indicated by the pyrometer. The muffle and its contained crucible are in the vertical position until the instrument is started revolving. The cup carrying the investment to be cast into is inverted over the crucible.

"Since the rate of the revolution is a constant factor in determining the actual pressure, together with the weight of the column of fluid, and the radius of the circle, an indicating needle is geared to the driving shaft, and indicates the pressure being exerted by the fluid gold.

"When ready to cast, the head carrying the muffle, crucible and investment is revolved by the hand lever, and the heat remains on until it automatically releases itself by a counterweight condensing a spring and opening a latch. The gold thus enters the investment at high pressure and at the full heat. Twenty per cent. platinum in gold can readily be melted in it.

"Large cups are used for large cases like plates and bridges.

"It is particularly valuable for casting into hard models, like the artificial stone which can withstand a very high pressure without distortion."

The most popular machines, because of their cheapness and simplicity, are those of the press or stamping form, and the Seymour is representative of that class (Fig. 291).

The metal is forced into the mold by wet asbestos packing pressed over the flask rim. This contact with the heat

produces steam, which forces the molten metal into the mold. Bridges and full dentures are successfully cast with these appliances.

Investment Compound.—Successful casting does not always depend upon the machine employed, as due consideration must be given to the technic and the quality of materials used such as wax and investment. These articles are as varied as the machines and their merit depends largely on the manipulator, although it is now generally conceded that an investment composed of three parts of powdered silex to one of best impression plaster will give the best results under all circumstances.

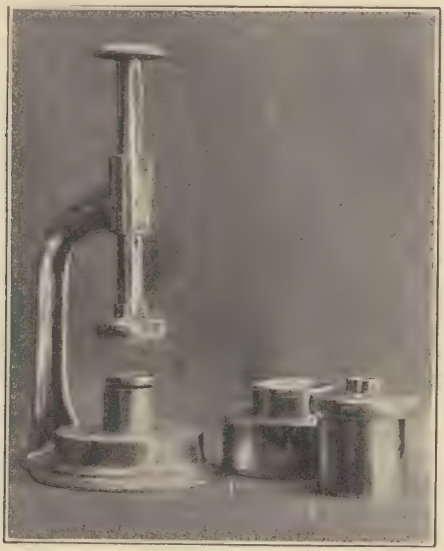


FIG. 291.—Seymour's casting machine.

ALEXANDER'S METHOD OF MAKING GOLD INLAYS.

This is a simple and rapid way of making gold inlays, and with a little experience, accurate results can be obtained. A plastic moldable gold is made especially for this purpose,

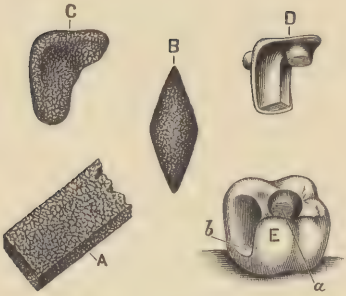


FIG. 292.—*A*, plastic gold for making inlays; *B*, portion of plastic gold molded into a double cone; *C*, the same teased into approximately the shape of the cavity; *D*, fused inlay, showing excess of gold in button at the left; *E*, cavity prepared with flat seats, *a* and *b*, to support the inlay.

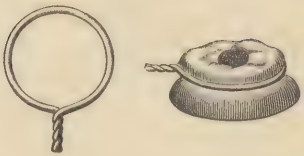


FIG. 293.—Soft iron loop, as made and as embedded in position on the investment, in the crater of which is seen the plastic gold ready to receive the solder.

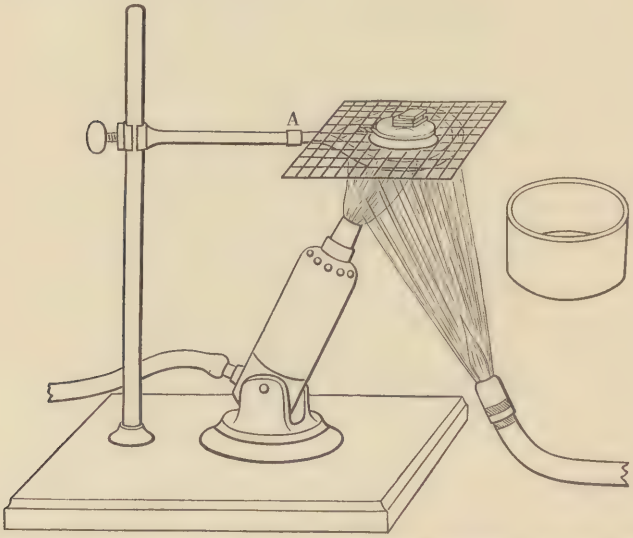


FIG. 294.—Soldering apparatus: Adjustable gas-burner, soldering frame and support, with investment in position, with the flame properly applied. The ring for confining the flame is placed on the wire frame around the investment and another wire frame on top of the ring.

and is used in the following manner: Tear from the plastic gold mat a piece of gold of sufficient size and compress into a double-headed cone, using the greatest force possible with the fingers, then introduce it to the cavity prepared as in Fig. 292. These cavities in bicuspids and molars are prepared with a retention pit, differing from other cavities formed for inlay work. The cavity and gold are kept dry until the gold is packed with instrument pressure, using various sizes of burnishers for this purpose. The gold being very plastic it can be handled similar to a wax impression, noting the occlusion and finishing the surface in the same manner.

If the gold pellet is deficient in size it can be added to, providing the surfaces are dry when the form is complete; it is then removed from the cavity and invested. The investment is made to form a slight crater-shaped gateway through which the gold solder enters when placed and fused upon this surface (Fig. 293); 20 or 22 k. solder should be used for solidifying, cut into small squares and mixed with freshly ground crystal borax.

The piece is slowly heated over a Bunsen burner (Fig. 294), then with a broad brush flame from the blow-pipe, causing the solder to fuse and be absorbed by the gold within the investment. Before seating the inlay, it should be finished with a corundum wheel, being careful to trim away all overlaps along margins.

No time whatever is lost in making inlays by this method, as the heat is applied while the investment is green. The paper upon which it is made is burnt up in the process of solidification. Sump is used for the investment, as it does not disintegrate from immediate application of heat.

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